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The following alterations are made, partly on the suggestions of Professor SILLIMAN, and partly from my own observations while reviewing the strata in various parts of New-England and New-York, since the Index was published.

A. E.

Albany, Dec. 10, 1818.

I. PRIMITIVE CLASS.

- | | | |
|--|--------------------------------|-----------|
| 1. GRANITE. | In the Index it is included in | No. 1. |
| 2. GNEISS. | - - - - | 3. |
| 3. SIENITE. | - - - - | 7. |
| Often alternates with the two next strata. | | |
| 4. MICA-SLATE. | - - - - | 3. |
| 5. TALCOSE ROCKS. | - - - - | 3. |
| 6. GRANULAR LIMESTONE. | - - - - | 2, 6 & 8. |
| Often connected with the granular quarts; and alternates with the four preceding strata. | | |

II. TRANSITION CLASS.

- | | | |
|---|---------|----------|
| 7. AGILLACEOUS SLATE. | - - - - | 9. |
| Often passes into the siliceous slate. | | |
| 8. GRAYWACKE. | - - - - | 10 & 11. |
| Often passes into rubblestone and variegated sandstone. | | |

III. SECONDARY CLASS.

- | | | |
|---------------------------------------|---------|-----|
| 9. RED SANDSTONE (sometimes wanting.) | - - - - | 12. |
| 10. BRECCIA (sometimes wanting.) | - - - - | 13. |
| 11. COMPACT LIMESTONE. | - - - - | 11. |
| Often contains organic relics. | | |
| 12. GYPSUM. | - - - - | 15. |
| Sometimes connected with rocksalt. | | |

IV. SUPERINCUMBENT CLASS.

- | | | |
|--|---------|-----|
| 13. GREENSTONE TRAP. | - - - - | 17. |
| 14. BASSALT. | - - - - | 17. |
| Mostly porous and becoming amygdaloid. | | |

V. ALLUVIAL CLASS.

- | | | |
|--|---------|-----|
| 15. GEEST. | - - - - | 18. |
| This is the common soil of hills, declivities, &c. | | |
| 16. PROPER ALLUVIAL. | - - - - | 18. |
| This is the deep soil of low level situations. | | |


mark.—Coal is found in the United States, sometimes beneath bituminous shale, and sometimes between strata of micaceous stone.

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Eocene
 Cretaceous
 Jurassic
 Triassic
 Permian
 Carboniferous
 Devonian
 Silurian
 Ordovician
 Cambrian 148
 Etcheminian 4
 Huronian
 Grenvillian
 Archean 34 84 84
 34 84



AN
INDEX TO THE GEOLOGY

OF THE
/ NORTHERN STATES, 1829

WITH TRANSVERSE SECTIONS,
EXTENDING FROM SUSQUEHANNA RIVER TO THE ATLANTIC,
CROSSING CATSKILL MOUNTAINS.

TO WHICH IS PREFIXED
A GEOLOGICAL GRAMMAR.

BY AMOS EATON, A. M.

LECTURER ON NATURAL HISTORY AND CHEMISTRY IN THE TROY
LYCEUM, PROFESSOR OF BOTANY IN CASTLETON MEDICAL
ACADEMY, MEMBER OF THE AMERICAN GEOLOGICAL
SOCIETY, AND CORRESPONDING MEMBER OF THE
NEW-YORK LYCEUM OF NATURAL HISTORY.

SECOND EDITION,

WHOLLY WRITTEN OVER ANEW, AND PUBLISHED UNDER
THE DIRECTION OF THE TROY LYCEUM.

"Systems of Natural History, however voluminous, are but
INDEXES to the great book of Nature."

TROY, N. Y.

PUBLISHED BY WM. S. PARKER; SOLD BY HIM; BY WEBSTERS AND
SKINNERS, ALBANY; T. AND J. SWORDS, NEW-YORK; HOWE AND
SPALDING, NEW-HAVEN; G. GOODWIN AND SONS, HARTFORD;
CUMMINGS AND HILLIARD, BOSTON; S. BUTLER, NORTHAMPTON;
AND M. CAREY AND SON, PHILADELPHIA.

.....
1820.

Northern District of New-York, to wit :

BE it Remembered, That on the tenth day of April, in the forty-fourth year of the Independence of the United States of America, A. D. 1820, WILLIAM S. PARKER, of the said District, hath deposited in this Office the title of a book, the right whereof he claims as proprietor, in the words following, to wit :

" Index to the Geology of the Northern States, with transverse sections, extending from Susquehanna river to the Atlantic, crossing Catskill mountains. To which is prefixed a Geological Grammar, by AMOS EATON, A. M. Lecturer on Natural History and Chemistry in the Troy Lyceum, Professor of Botany in Castleton Medical Academy, Member of the American Geological Society, and Corresponding Member of the New-York Lyceum of Natural History. Second Edition, wholly written over anew. " Systems of Natural History, however voluminous, are but INDEXES to the great book of Nature."

In conformity to the act of the Congress of the United States, entitled " An act for the encouragement of learning, by securing the copies of Maps, Charts, and Books, to the authors and proprietors of such copies, during the times therein mentioned ;" and also, to the act, entitled " An act, supplementary to an act, entitled ' An act for the encouragement of learning, by securing the copies of Maps, Charts, and Books, to the authors and proprietors of such copies, during the times therein mentioned,' and extending the benefit thereof to the arts of designing, engraving and etching historical and other prints."

RICH D. R. LANSING,
Clerk of the Northern District of New-York.

WM. S. PARKER, PRINTER.

P R E F A C E.

THE first edition of this Treatise was intended for my pupils, as an Index to the localities where they were to look for specimens to illustrate this branch of Natural Science: not, however, without the expectation that it would fall into the hands of many others. It was then a matter of doubt, whether I was to expect severe criticism or total neglect. It now appears, that *learned* geologists were inclined to give me more credit, than I had a right to claim.* While some others, who derived their small stock of geological knowledge entirely from my labours, make a great display, without so much as noticing my little book or its author.

* See American Journal of Science, North American Review, New-York Monthly Magazine, &c.

The first edition contained many errors. In truth, the errors are so numerous, that I shall not attempt to point them out. But I shall treat the subject as I now understand it; without detaining the reader with any apologies for former mistakes. I am very willing it should be said, that, “as this was the first attempt at a general arrangement of geological strata in North America, much allowance should be made.” I should not, however, feel greatly mortified, if closet critics should object to my plain unvarnished “matter of fact” method; and even if the more able theorists should accuse me of placing too much confidence in my own observations and opinions. I now answer them all at once. Go to the localities to which my Index refers you, and let Nature herself decide our controversies.

With respect to the theoretical part, as far as I have given in to any theory, it is to that of Werner, with the improvements of Cuvier and Bakewell.* But I hope I have no where compelled fact to bend to any theory. I expect to be censured for rejecting so many of the strata, which are given by European geologists. My reply is a short one—I do not

* It is much to be regretted, that Bakewell is not yet reprinted in America.

*insert them, because I cannot find them.** If future discoveries bring more strata to our knowledge, they will be adopted of course. It is certainly most advisable to begin with those only, which have been clearly ascertained; and calculate to increase our list, when we shall be authorized by facts.

As the arrangement adopted in this work is wholly founded upon my own observations, it will be proper to mention some of the leading localities by which I was governed. I have attentively examined most of the western towns in Massachusetts, and a large portion of the eastern; every county in Connecticut; and the southwestern part of Vermont. Also, all that portion of the state of New-York, which lies between the west bounds of Massachusetts and the Susquehanna river; embracing the whole extent of the Catskill mountains. Most of the counties of Saratoga, Schenectady, Rensselaer and Albany, I have repeatedly examined with very particular attention. The district of country, which I have attentively studied for the last four years, is about one hundred and fifty miles in breadth; through the southern part of which runs the 42d degree of north

* McClure says: "Many names I do not use; because I never met with them."

latitude, and it extends very nearly from the 71st to the 76th degree of west longitude. I have also taken a hasty survey of the southern part of the state of New-York. My journies on foot, while in search of geological facts, will now exceed two thousand miles; leaving out of the account all my excursions in the vicinity of Troy and Albany, and more than another thousand of carriage and water travelling.

Though I repose perhaps an unwarrantable degree of confidence in the arrangement of strata which I have adopted, more especially since it has been confirmed by the researches of so many members of the Troy Lyceum and others; yet I am prepared to adopt any amendments which future discoveries shall warrant.

It is not pretended that many principles absolutely new will be developed in this work. Nothing more is promised, than a faithful application, to North American Geology, of those principles which have been brought to light by the researches of the learned geologists of the old and new world. The President of the American Geological Society, William M'Clure, Esq. has already struck out the grand out-

line of North American geographical geology. The first Vice-President, Col. G. Gibbs, has collected more facts and amassed more geological and mineralogical specimens than any other individual of the age. The second Vice-President, Professor Silliman, his learned and indefatigable colleague in these labors, gives the true scientific dress to all the naked mineralogical subjects, which are furnished to his hand. The third Vice-President, Professor Cleaveland, is successfully employed in elucidating and familiarizing those interesting sciences; and thus smoothing the rugged paths of the student. Professor Mitchill has amassed a large store of materials, and annexed them to the labors of Cuvier and Jameson. But the drudgery of climbing cliffs and descending into fissures and caverns, and of traversing, in all directions, our most rugged mountainous districts, to ascertain the distinctive characters, number and order of our strata, has devolved on me. I make no pretensions to any peculiar qualifications, other than that bodily health and constitutional fitness for labor and fatigue, which such an employment requires.

The short courses of Geological Lectures, which I have given in the villages and towns situated in

various parts of this district, have afforded me many advantages. More than one thousand of my pupils reside within its limits, many of whom have collected very interesting materials in aid of my purpose.

I have prefixed a concise grammar of geology for the benefit of students. This I have accommodated to my views of North American geology.

I consider nothing in geology entitled to much confidence, which is purely theoretical. But I am willing to be held as pledged for every fact given as such in this Index; unless there are cases (which I hope are few) where I misjudged respecting the name or character of a mineral or stratum.

Since the scientific world will no longer endure geological reveries and speculative dreams, it becomes necessary to cite the authority by which every position is supported. This renders a multitude of names of persons and places indispensable. I am sensible that a treatise defaced with so many proper names has a forbidding aspect; but without them it would appear to be a record of assertions rather than a record of facts.

A distinct treatise on the geology of our district is still wanted; and it is to be hoped that it may ere long appear. I mean a treatise on the local formations. Schoolcraft's View of the Lead Mines of Missouri is a sample of that kind of research, which should engage the attention of at least one experienced geologist in every state.*

• I have lately received a letter from Dr. H. H. Hayden of Baltimore, by which I am happy to learn, that he has prepared a volume of essays on several geological subjects, which is soon to be published. This information must be highly gratifying to those who have heretofore been instructed by his labors.

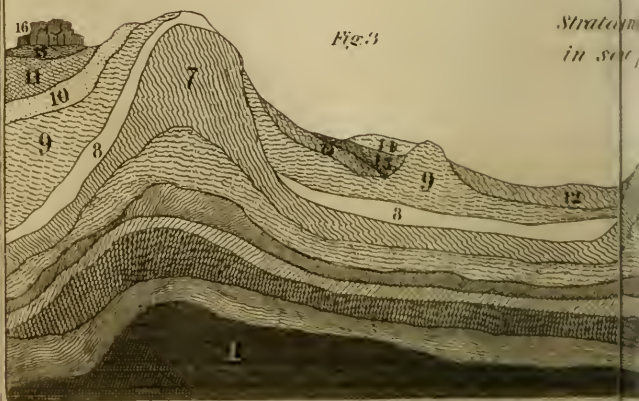
DIRECTIONS FOR THE PLATES.

* * Both plates are to be put in as maps are set in an Atlas. They are of a size just sufficient to make two leaves equal to the leaves of the book, provided the slips of paper to which they are attached are so narrow as to bring the middle of the plates near the back.

Plate I, must follow this page. Plate II, must follow the Explanations on page 280.

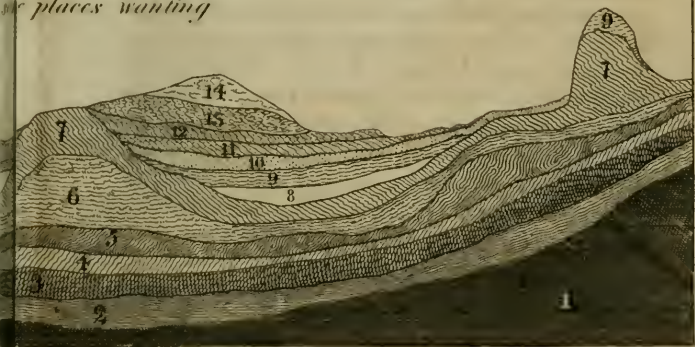


Fig. 1





interrupted undulated and
places wanting





EXPLANATION OF PLATE I.

FOR the convenience of learners, I shall adopt the following theory.

That at the creation, the materials constituting the earth were finely comminuted and mixed with water, so as to form the chaotic paste. That these materials united together by attraction of cohesion or aggregation, and settled down towards the center in layers arranged nearly in the order of their specific gravities.*

* It has been demonstrated by Dr. Maskeline and others, that what is below the granite all taken together is about five times as heavy as a globe of water of the same bulk, or has about double the specific gravity of the granite and all above it. The proof of this fact is founded on the deviation of a plum-line from a true perpendicular, when suspended by the side of an insulated mountain of naked rock. The specific gravity of the mountain may be ascertained by actual trial of average specimens from it. Its cubic feet may be found by measure; and the cubic feet contained in the earth may also be found by calculation. The deviation of the plum-line should be as the cubic feet of the

Consequently concentric hollow spheres were formed, enclosing each other like the coats of an onion. These are represented by Fig. 1.

The Granite is denoted by No. 1, Gneiss 2, Hornblende rock 3, Mica-slate 4, Talcofe rock 5, Granular limestone 6, Argillite 7, Metalliferous limestone 8, Graywacke 9, Red sandstone 10, Muddy waters surrounding the earth 11. The four outer strata called transition rocks, were formed after some marine animals were created; as such animals are now contained in them, in a state of petrification.

The outer rocks, denominated secondary, which sometimes contain petrifications of organized beings, which inhabited *dry land*, are of more recent formation and not represented in the figure. In a very early state of the earth there were probably many local formations under water such as Superincumbent rocks, Alluvials, &c.

mountain to the cubic feet of the earth. But it turns out to be but half as much as it should be, when the specific gravity of the rock is two and a half. Therefore the earth is five.

That in due time some force (perhaps the expansion of steam by the agency of the internal heat of the earth) was exerted beneath the granite, sufficient to overcome the weight and strength of the granite and of all the rocks outside of it. That this force, extending around the earth between the granite and the unknown stratum next beneath it, at length burst forth driving the granite through the outer strata in several places, and thereby raising up their broken edges into a highly inclined position. By this process islands, or even continents, of rocks, and perhaps supporting some submarine soils, were raised out of the waters hitherto enveloping the earth.

That the uppermost of the elevated strata, being most exposed and of a soft texture, soon crumbled down and formed soils suitable for the production of vegetables and the habitation of animals. These organized beings were frequently swept into the sea and sometimes intermixed with marine relics. From continued abrasions and disintegration rocks above and below the waters were reduced to pebbles, sand and paste, from which new rocks were formed.

These most recent rocks entombed both marine and land relics. After a further subsidence of the waters many of these rocks were left bare also ; which are now called Secondary rocks.*

That the rents made by the grand explosion, which first upturned and disfigured the rocky crust of the globe, were in a north and south direction. That those, crossing the 42nd degree of north latitude, were principally made at the Pyrenees and Alps in Europe, Caucasus, Tartary and China in Asia, Rocky Mountain and New-England in America. They are represented in Fig. 2.

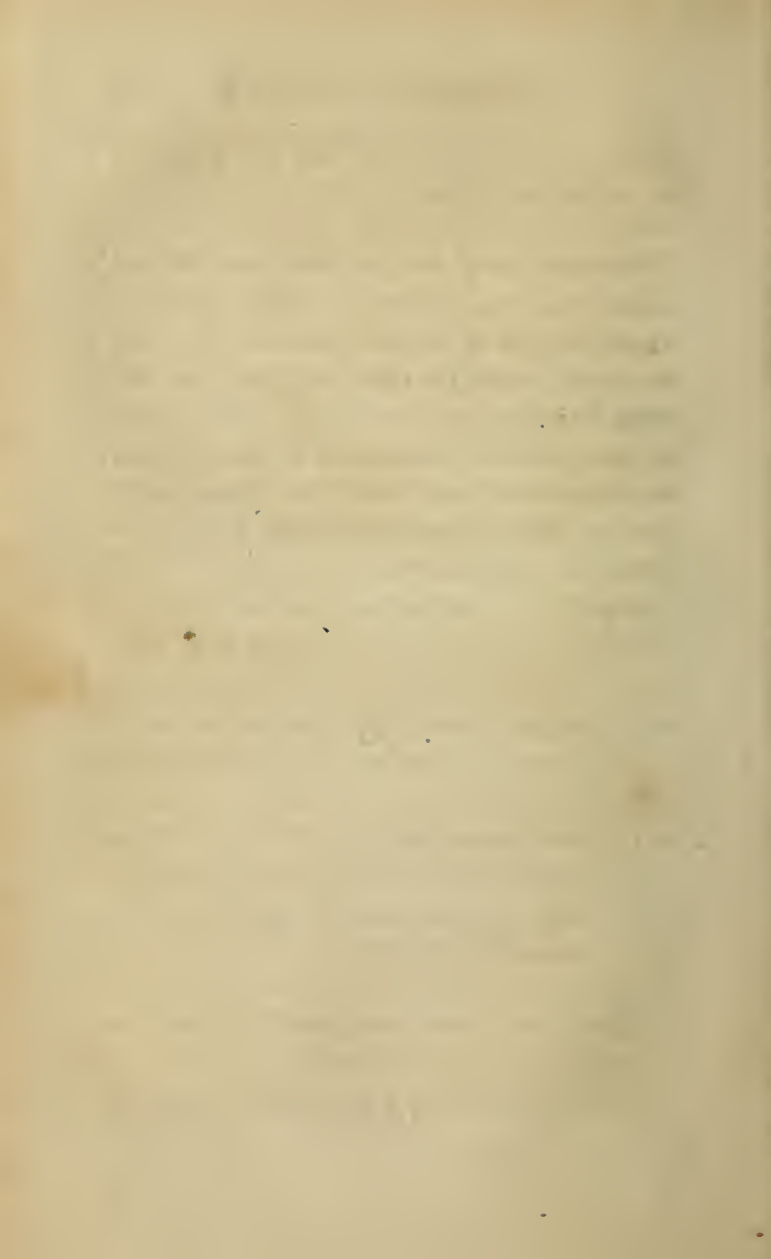
The north and south rents now constitute the central lines of the leading ranges of primitive rocks, from which the series of rock strata are reckoned. Other more limited explosions, called volcanoes, have frequently occurred ; which, with inundations and other causes, gave rise to many local formations.

Figure 3. represents a section of secondary

* Have petrifications of *dry-land* animals or plants been found in rock strata highly elevated ?

country, where all the old and new strata are supposed to be present.

Whether this theory accords with the real origin of the present state of things or not, is immaterial. It is introduced solely for the purpose of aiding the memory in studying the strata, which we know do exist. It is preferred for this use; because it is more simple and seems to accord with more phenomena, than any theory hitherto suggested.



GRAMMAR
OF
GEOLOGY.

ALPHABET.

THOSE, who are unacquainted with Mineralogy, can make no progress in Geology, without a familiar acquaintance with nine homogeneous minerals. Every stratum consists of one or more of these nine minerals; therefore they are aptly denominated the Geological Alphabet. They are, 1. Quartz, 2. Felspar, 3. Mica, 4. Talc, 5. Hornblende, 6. Argillite, 7. Limestone, 8. Gypsum, 9. Chlorite.

I. QUARTZ. When held between the eye and a window, it reflects light somewhat like a polished piece of cold tallow. This is called its lustre. On attempting to scratch it with a

penknife, the metal will leave a trace on it, and it will not be scratched. It is commonly glass-colour, but it is often milk-white, reddish, and of various other colours. Quartz consists of about 93 per cent flint, 6 alumine or clay, 1 lime, besides 2 or 3 per cent of water in a solid state.

II. FELSPAR, or FELDSPAR. Its lustre is peculiar; but it in some measure resembles that of a broken edge of china ware. It may be scratched with a knife. Its colour is generally white or flesh-coloured. It is best ascertained when in the state of a rock aggregate by procuring an outside fragment, which had been long exposed to air and moisture. In this state it always assumes a peculiar tarnish, of a yellowish hue. Felspar consists of about 63 per cent flint, 17 alumine, 13 potash, 3 lime, 1 iron, 3 water.

III. MICA. It is always in shining laminae or scales. It is every where known by the improper name of isinglass. The scales are always elastic. It consists of 48 per cent flint,

34 alumine, 9 potash, 5 iron, 1 manganese, 3 water. Black mica contains 22 per cent iron.

IV. TALC. It often resembles mica ; but can readily be distinguished from it by being non-elastic. Take a small scale or fibre of it in a pair of tweezers, put it under a magnifier and bend it with the point of a fine needle. If it remains as it is bent, it is talc ; if it springs back it is mica. It always gives a rock the unctuous or soapy feel. It consists of 62 per cent. silicæ, 27 magnesia, 2 alumine, 3 iron, 6 water.

V. HORNBLENDE. It is the toughest of all earthy minerals. Generally it presents a kind of confused fibrous structure. It may be scratched with the knife. The colour is always greenish, brownish or black. Sometimes it appears in black scales, resembling black mica to the naked eye. But under the magnifier it differs materially. It consists of about 42 per cent silicæ, 12 alumine, 11 lime, 3 magnesia, 3 iron, 1 manganese, 1 water.

VI. ARGILLITE. This needs no description. The common roof-slate and the slate us-

ed for cyphering in schools are good specimens. It consists of about 38 per cent flint, 26 alumine, 8 magnesia, 4 lime, 14 iron, 10 of potash, soda, manganese, water, &c.

VII. LIMESTONE. Common marble affords good specimens. It should be tested by a drop of muriatic, nitric or sulphuric acid, which will cause an effervescence or bubbling. It consists of 57 per cent of lime, 43 of carbonic acid. Sometimes it is coloured with iron and often contains a little flint and alumine.

VIII. GYPSUM. Common plaister of Paris. It will not effervesce with acids and is generally softer than limestone. It consists of 32 per cent lime, 46 sulphuric acid, 22 water.

IX. CHLORITE. It is a little harder than talc, but may be scratched with the finger nail. Under the magnifier it appears like a compact mass of fine green scales. When breathed on it gives an odour in some measure resembling clay. Its elementary constituents are variable. They will average about 40 per cent flint, 23 alumine, 18 magnesia, 15 oxid of iron, 2 lime, 2 water. This is the least important of the whole nine.

After students can readily recognize these nine minerals, they should be exercised in pointing them out in their various states of aggregation. They will soon be enabled to spell out any rock with facility.

CLASSES.

THE exterior rind of the earth is divided into five classes.

CLASS I.

PRIMITIVE ROCKS.

These are the six kinds, which, while they remain in their original positions undisturbed, are the lowest with which we are acquainted. They are distinguished from all the rocks of the other classes by their being always destitute of organic relics, or the petrified remains of animals and vegetables. They appear to have been originally formed in horizontal strata; and afterwards to have been forced upwards, in some parts of the earth, by a power exerted beneath them, resembling in its effects the expansion of steam by heat. These strata, when

thus forced up, mostly approach a vertical position. In North America this class of rocks appears in North and South ranges.

CLASS II.

TRANSITION ROCKS.

These are the four kinds, which rest immediately upon the primitive class, or incline against its sides. They are distinguished from the rocks of the primitive class by their containing organic relics. And they are distinguished from the secondary class by their containing no petrifications but those of marine origin.

CLASS III.

SECONDARY ROCKS.

These are the four kinds, which are the uppermost in the series of regular rock strata. They are distinguished from the two preceding classes by their containing, not only marine petrifications, but those also which are of dry-land and fresh-water origin.

It is probable that future discoveries will compel us to add another class, to embrace LOCAL FORMATIONS.

CLASS IV.

SUPERINCUMBENT ROCKS.

These rocks overlay others in a non-conformable position. In our district they generally rest upon breccia or red sandstone; and are always above primitive hornblende rocks. They are mostly granular aggregates in which one essential constituent is hornblende. When wet they exhibit a greenish hue. A columnar, polyhedral, or rhomboidal tendency is always manifest. Bakewell and many others consider them of volcanic origin.*

* Bakewell is inclined to believe, that Sienite is of volcanic origin also. But the position of every variety of sienite in our district gives the highest evidence, that it is exclusively a primitive rock. From the position of the greenstone trap at Deerfield and Northampton, Mass. it would not require a great effort of fancy to conceive it to have been formed of melted primitive hornblende rock; as this stratum undoubtedly passes beneath it, and we have no evidence that a communication between them is not made by a rent through the interposed strata.

CLASS V.

ALLUVIAL FORMATIONS.

These are the various loose layers, which are formed of disintegrated or broken rocks. Sometimes these broken fragments, even though pulverized, are cemented together, forming puddingstone, calcareous breccia, indurated marl, &c. But this formation consists chiefly of gravel, sand, clay and loam. The indurated masses may be denominated alluvial rocks.

VOLCANIC PRODUCTIONS.

These do not form a distinct class of geological strata; though perhaps they may belong to the superincumbent class. Any minerals, upon which changes have been wrought by volcanic fires, belong here.

The most common kinds of volcanic productions are: **LAVA**, which seems to be composed chiefly of melted hornblende slowly cooled—**OBSIDIAN**, which is the same as lava cool-

ed suddenly—**PUMICE**, which is said to be formed chiefly of melted felspar—**TUFA** or **VOLCANIC BRECCIA**, which is an aggregated mass of volcanic stones, cemented together by volcanic ashes.

REMARK.

Although the arrangement adopted in this Grammar corresponds with the order of strata, viewed on a large scale; yet much confusion often obtains in limited localities. A good example may be found in the avenue to the Southampton lead mines, Mass. See the American Journal of Science, page 136. Here the general strata are only Granite, Mica-slate, Talcoſe rock and Alluvion including coal between layers of micaceous sandstone, &c. though an aggregate resembling Graywacke, also serpentine and Mica-slate, alternate with the Granite.

Another very important locality is to be found in the west part of Massachusetts. Near the south bounds of the state there appears to be but one range of granular limestone, and that in its true place, as located in the system of ar-

range. But on pursuing this stratum a very little distance to the north, it divides into two extensive ranges, continuing far into the state of Vermont. And southerly it divides into three ranges, which in some places diverge from each other to the distance of several miles. A little south of Williams College, the ranges of this stratum are separated by a mountain of gneiss, mica-slate, talcose rock, and granular quartz, 24 hundred feet in height. Though in this locality there appears to be great confusion in the order of strata; if our examinations are sufficiently extended, uniformity in the arrangement of analogous rocks becomes manifest.

S T R A T A.

EACH class is subdivided into strata.

I. PRIMITIVE CLASS.

1. *GRANITE.**

It consists of quartz, felspar and mica, aggregated irregularly ; presenting a granular, not a slaty appearance. It may be coarsely or finely granulated. The oldest rocks are generally the coarsest. When the felspar is white, it is called grey granite ; when flesh-coloured, red granite ; when blue, which is rare, blue granite. It often forms veins, traversing gneiss

* Any rock stratum may contain many other minerals besides those, which are essential. These are to be considered as accidental and are not to be taken into view in determining the character of a rock. For example, if shorl or beryl be found in granite, the rock is granite, notwithstanding.

and hornblende rocks. Sometimes it contains very hard serpentine.*

2. *GNEISS.*

It consists of quartz, felspar and mica, but is distinguished from granite by the arrangement of the mica. For the scales of mica are mostly arranged in layers, so as to give the mass, if broken crosswise, a flaty or stratified appearance. It is generally finer grained than granite, and contains a less proportion of felspar. The quartz is sometimes very abundant and fine-grained, so as to present a sand-like appearance. When it approaches the horizontal position, it often passes into, or rather embraces, a kind of rock in some measure resembling graywacke. This is considered as the most recent variety.†

3. *HORNBLENDE ROCK.*‡

It consists essentially of aggregated hornblende

* As in Westfield, Mass. and the Highlands, N. York.

† The northwest part of the county of Saratoga presents a vast extent of this variety.

‡ This was called Sicnite in the 1st Ed. But that name, like

and felspar. Excepting the superincumbent class, there appears to be no rock in the Northern States of which hornblende is a constituent, only this stratum. Sometimes it is composed of green, or brownish green hornblende, beautifully speckled with white felspar.* Sometimes it consists mostly of dark brown hornblende, is of a slaty structure, and breaks readily into suitable forms for building stone.† It often contains beds of porphyry.

Trap, has been so variously applied, that I have been induced to adopt a descriptive name, which is at least harmless.

* Most authors apply the name Sienite, to this variety, making it a distinct stratum; and name the slaty variety of hornblende rock Primitive trap. This distinction will do very well for labelled specimens in a cabinet. But the vast ranges of this rock which pass through Worthington, Plainfield, Belchertown and Framingham, Mass. prove both these varieties to be the same rock; for they both often pass into each other in the same continuous layer.

† This stratum alternates with so many other primitive rocks, that it is somewhat difficult to locate it in the system. But after several attentive re-examinations, I find, that all the ranges, mentioned in the last note, rest upon gneiss. At Haddam quarries, Conn. the slaty variety alternates with gneiss. But the larger ranges ought to controul in questionable cases.

4. *MICA-SLATE*.*

It is essentially composed of mica and fine-grained quartz. It is of a slaty structure and easily broken or split. When the hornblende rock is not interposed, it passes into gneiss. Some varieties of it can hardly be distinguished from the softest varieties of gneiss.

5. *TALCOSE ROCK*.†

It consists essentially of talc and quartz very finely comminuted. It passes into mica-slate. The meeting and mixing of these two strata produce the common scythe whetstone,‡ and one variety of the sand used in glass factories.§

* Called also Micaceous schistus. In the Northern States this is not generally a very extensive stratum.

† I adopt this name by the advice of Professor Silliman, as a substitute for steatite or soapstone. He has the authority of Professor Strouve, in support of his own opinion.

‡ As near the northeastern part of Belchertown, Mass. and in Smithfield, R. I.

§ As in Berkshire county near Lenox, Mass.

The micaceous iron ore is also formed at this meeting of strata.*

6. GRANULAR LIMESTONE.

It consists essentially of glimmering grains of limestone. Sometimes a large proportion of the rock consists of grains of quartz forming a kind of calcareous sandstone. It is generally associated, or alternates, with large beds of granular quartz; even mountain masses.† It frequently alternates with several of the preceding strata.‡ Sometimes it contains Serpentine.§ Sometimes it passes into Dolomite.||

* As in Hawley, Mass.

† As those near Williams College, Mass.

‡ See Remark, Page 29.

§ As the Milford quarry, Con.

|| As in Canaan, Con.

II. TRANSITION CLASS.

7. ARGILLITE.*

It is homogeneous in its appearance ; being the same as the sixth mineral described in the geological alphabet. Like the slate of Charnwood forest, England, mentioned by Bakewell, the flaty laminae in our district generally make a large angle with the planes of the seams separating the layers. Sometimes they are nearly vertical and curvilinear. Most of the layers are of vast thickness. It passes into siliceous or

* The shining argillite, or proper primitive slate, is an imbedded, or subordinate, rock, found only with primitive rocks. The President of the Troy Lyceum found it with granite in Vermont. I found in Schoharie county a very soft variety of argillaceous rock in an extensive bed containing fibrous sulphate of barytes. It seems to be a soft variety of gravwacke, under, and in immediate connexion with, compact limestone. Neither of these varieties can be mistaken for the stratum here intended : and they have no connexion with it.

Hinty slate; and is often traversed by veins of white quartz. It frequently embraces large ANOMALOUS aggregates. Near Troy and Albany it is often varnished with carburet of iron. It contains petrifications of *orthocerites*, *pectenites* and *anomites*; but they are not frequently found.

3. METALLIFEROUS LIMESTONE.*

It is more compact than primitive limestone; but under the magnifier it seems to be essentially composed of very minute glimmering grains. It is generally harder and lighter coloured than the compact limestone and contains very few petrifications. Sometimes it is highly variegated in its colours. It sometimes alternates with the strata above and below its place. In South

* Called Transition limestone also. The existence of this stratum along the east side of Lake Champlain in Vermont, seems to be demonstrated by that very accurate naturalist, Dr. Edwin James. We have reason to suspect, that it alternates with argillaceous slate in Rensselaer and Columbia counties; but this subject has not been sufficiently investigated. I have a specimen from Potosi in South America, containing silver ore, which is softer and more variegated in colour, than the specimens from Vermont. See Dr. James' essay in a note further on.

America, and in most other countries it abounds in ores.

9. GRAYWACKE.

It consists essentially of grains of quartz cemented together by indurated clay. It is almost always of a dull grey colour, rarely a little greenish.* It may be distinguished from every variety of sandstone by magnifying its constituent particles. For the magnifier shews the empty interstices between the quartzose particles of all sandstones, which are chiefly filled up with alumine in graywacke. Graywacke will always crack and become fissile by heating, on account of the aluminous cement. Whereas sandstone will merely crumble to pieces, or become pulverized by heat.

There are two varieties of graywacke, which seem to pass into each other. They are denominated *rubblestone* and *graywacke-slate*. The former is harder, coarser and rarely contains any glimmering scales. Its constituents are from the size of a pin-head to several inches in ex-

* As that west of Milford quarry in Connecticut.

tent. Large pieces of slate are often embraced in it.* The slaty variety is the most extensive. It always, I believe, exhibits glimmering scales of talc or mica. It is the most variable of all rocks, and contains the most imbedded masses. It passes into a soft fine-grained variety, which is generally mistaken for argillaceous slate; but may be distinguished by the glimmering scales. This soft variety forms the best fine-grit grindstones and hones.† It is sometimes very irregularly fissile, so that it cannot be quarried.‡ Sometimes it is so compact that it takes a very good polish.§ It often embraces vast beds of coarse sandstone or gritstone.|| It abounds in ores in many places.¶ In our district it is the basis rock of more than ten thousand square

* The most perfect specimens of this variety are those, which are quarried at the south end of the bridge on Norman's Kill, two miles below Albany.

† As at Van Vechten's mill and Eaton's mill, Catskill, and at Patchen's mill in Blenheim, N. York.

‡ As in the east face of Catskill mountain, N. York.

§ As in Bucl's quarry near Troy, N. York.

|| As in Blenheim, N. York.

¶ The lead ore in Livingston's Manor is in this stratum.

miles.* It contains *anomites*, *pectenites*, *orthocerites*, *terebratulites*, *chamites*, *myites*, &c.

10. RED SANDSTONE.

It consists essentially of grains of quartz aggregated together, or perhaps cemented together by alumine and red oxyd of iron; but the interstices between the grains are not filled as in graywacke, but are more or less empty. It is red or reddish grey, sometimes passing into a grey coarse gritstone.† It contains petrifications of the *corallinites* in very great abundance.‡ It

* The members of the Troy Lyceum have taken great pains to obtain correct information respecting this stratum. It appears that European geologists have made several strata from it. But its great extent in our district, embracing the whole of Catskill mountain with all its vast western spurs, enables us to examine the relative positions of all its varieties on a large scale.

† As at the south end of Mount Tom, Northampton, Mass.

‡ According to the definition of the classes, this stratum must go into the Secondary class, if its petrifications are not of marine origin. Jameson says "on a general view, it might be viewed as the newest member of the transition class." He leaves it in the Secondary however. This he ought to do, if he is correct in considering these petrifications as the "trunks or branches of trees," which they certainly resemble. I fell into the same error in the first edition of the Index. I think some of the specimens in

alternates with the upper layers of graywacke. This is the common red freestone.

the Troy Lyceum clearly demonstrate these relics to be of marine origin. Though they do not contain a particle of carbonate of lime, which we should expect generally to find in most species of Martin's genus *Erismatolite*; yet some species of his section *Ceratalinarum* appear to have been originally corneous. And even the whole species *Corallinite* may not have been calcareous.

Bakewell places it here; and M'Clure says he should incline to the same arrangement. Therefore on this authority, the suggestion of Jameſon, its alternating with graywacke, and embracing marine relics only, I have concluded to place it in this claſs.

III. SECONDARY CLASS.

11. BRECCIA.*

It consists of coarse grains of various rocks aggregated or cemented together, mostly by alumine, and red oxyd of iron. Some of the grains are always rounded. They are from

* This stratum is sometimes omitted by geologists. But it is such an universal associate with red sandstone in our district, that it cannot be omitted. As it is manifestly of more recent formation than the sandstone, it will introduce confusion in the system to treat it as a subordinate rock. No two rocks are more distinctly marked by invariable characteristics than these. The sandstone is entirely made up of angular grains mostly of the same kind; breccia mostly of rounded ones, of very different kinds. There is some difficulty in distinguishing hand specimens from Puddingstone. But as the latter is an alluvial rock, or a mere mass of cemented gravel, there can be no difficulty, when examined in place. Some of the most decisive localities are those of Catskill mountains, Deerfield and Northampton, Mass. Middletown, Conn. Calcareous and Silicious breccia have no connexion with this stratum. They are subordinate to other rocks. Also the quartzose breccia used for millstones.

the size of a pin-head to that of several feet in extent. It always rests upon red sandstone in our district.

12. *COMPACT LIMESTONE.**

It consists chiefly of carbonate of lime, which is not made up of glimmering grains, but has a more dull earthy appearance. Particles of considerable lustre are often interspersed throughout large masses of it ; but these are imperfect crystals, very different from the glimmering grains of granular limestone. Sometimes it is traversed by veins of very perfect crystals ; sometimes it contains masses of imperfect crystals, called calcareous spar. It is rarely, if ever, pure ; but generally contains considerable alumine or flint. Isaac M'Conihe, Esq. presented specimens of the white Lithographic stone to the Troy Lyceum, which he found alter-

* It is called Shell limestone, and Floetz limestone. It rests upon graywacke, when the red sandstone and breccia are wanting ; as in the Heldeberg, southwest from Albany. Jameon makes several strata of this ; and among them interposes variegated sandstone, bituminous shale and coal. Perhaps these may be distinguished in our district. Until they are, we may consider them as subordinate to this stratum.

nating with this stratum in Indiana. In our district it seems to be chiefly made up of semi-disintegrated shells, held together by a cement composed of the disintegrated parts. Its colour is generally blue or brown.

13. GYPSUM.

It is homogeneous, being the same as the eighth mineral described in the Geological Alphabet. In our district it is frequently combined with carbonate of lime; and is often dark coloured, and even black. Salt springs are frequently found in the vicinity of this stratum; which has induced many to believe that a stratum of rock salt was once in connexion with it in the western part of the state of N. York, &c.*

14. SECONDARY SANDSTONE.

It consists of quartzose particles simply ag-

* Since the same range of gypsum extends into the regions of the Mississippi, according to M'Clure, where rock salt is still found; have we not good reason to believe that these two strata exist in connexion, or in the vicinity of each other, wherever salt springs abound? It is undoubtedly the most rational conjecture, that the salt springs are supplied by the continued solution of rock salt, which lies beneath the alluvial deposits.

gregated together, or mixed with grains of limestone or with clay. It is very various in colour and texture, from coarse gritstone to the fine-grained and almost compact.* *Phytolites* and other organic relics are found in this stratum.†

* I am not so well acquainted with this stratum, as I ought to be. It is probable that it might be divided into the Silicious, Argillaceous and Calcareous sandstone, in conformity with the divisions made by European geologists. But it may be placed under this general head, until it has been extensively examined. Myron Holley, Esq. a Canal Commissioner, informed me, that several varieties of this stratum frequently occurred along the course of the great Western Canal. The calcareous variety makes an excellent cement for the locks, which hardens under water. Specimens have been presented to the Troy Lyceum, confirming Mr. Holley's statement, which were collected in Indiana.

† On the Heldeberg, in the town of Bern, N. York, I found many petrifications of a culmiferous plant in the Silicious variety of this stratum. These are most abundant in and near a place called Pucker-street.

IV. SUPERINCUMBENT CLASS.

15. *BASALT*.*

It consists essentially of particles of hornblende, quartz and perhaps felspar, so extremely minute and so intimately comminuted, that it appears to be homogeneous. It generally rests upon breccia or red sandstone, and is beneath greenstone trap. In our district it is generally of the amygdaloid variety—that is, forming cavities resembling worm-holes in logs, which are either empty or filled with carbonate

* It has been said that we have no basalt in our district. But Bakewell considers the greenstone trap as a variety of basalt. I have carefully compared specimens of basalt from Scotland and from Giant's Causeway in Ireland, with those of Mount Holyoke near Northampton and of Deerfield, and I can discover no essential difference.

of lime, zeolite, &c. The most decisive localities are at Deerfield and Northampton, Mass.

16. *GREENSTONE TRAP.*

It consists of grains of hornblende, felspar and generally quartz, aggregated together; but never too fine to be distinguishable by the eye. It generally exhibits a columnar polyhedral tendency. The most decisive localities are at Deerfield and Northampton, Mass. at New-Haven, Con. and on Hudson river above N. York city.

V. ALLUVIAL CLASS.

17. *GEEST*.*

IT is that alluvial matter or soil, which seems to have ever remained near the place where it was first formed. It constitutes the earthy part of soils on hills or low lands, which is not generally very deep and was not derived from being washed down from the place of its original disintegration. As this kind of alluvial is generally formed at or near the place of its deposit; it consists mostly of the broken and pulverized fragments of the present existing rocks, or of those which have recently passed away. From an examination of it under the magnifier we may determine with considerable accuracy, what rock has recently decayed in that particu-

* This term is used by De Luc and defined by Jameson at the 192d page of the New-York Edition of Cuvier's Theory of the Earth.

lar spot. From an acquaintance with the existing rocks and by taking into view their homogeneous constituents, we may, on the other hand, judge of the soil which is now forming.

13. ALLUVION.

It is that alluvial deposit, which has been washed down from places where it was originally formed. It is often very deep, and is sometimes transported from a great distance. Consequently it is sometimes very difficult to trace it back to the rocks from which it was derived.* It being derived from various four-

* The Hon. Samuel Young, Esq. one of the Canal Commissioners, suggested to me (while I was giving a course of Agricultural lectures to the members of the legislature) that the barren sand-planes west of Albany might be traced to their origin. He observed, that he had frequently been forcibly impressed with what appeared to be the very track of this vast body of alluvial sand, as it moved down from that extensive range of gneiss rock, which commences in Saratoga county, and extends westerly. On collecting small quantities from various parts of these barren sands, we found the quartzose particles to be of that translucent hyaline variety, forming a constituent of primitive rocks. Scales of mica were also present, though in but small quantities. It is probable that the alluvial islands at the mouths of great rivers might generally be traced back to their origin by attentively studying their constituent particles, and comparing them with specimens of various rock strata mechanically pulverised.

ces, and formed of various materials; these materials on meeting in a state of solution or suspension in water, often form new indurated compounds. Such as buhrstone,* flint, indurated marl, puddingstone, &c. and several Anomalous aggregates. These latter may be called alluvial rocks, and each may be denominated according to its constituent elements.

Blocks and boulders are often found among alluvial deposits, as well as lying loose upon bare rocks far out of place, which were neither washed there, nor formed like alluvial rocks. Some geologists account for their removals by supposing them to have been transported by floating ice; others by imagining them to have been thrown up and scattered abroad by that power which burst forth beneath the granite, and forced up the primitive rocks through the upper strata.

The pebbles or gravel-stones in alluvion are always more or less rounded. Their rounded forms are to be ascribed to two causes—to roll-

* Mr. Schoolcraft and Mr. M'Conihe found buhrstone in Missouri

ing against each other by the action of water ; and to there being more surface exposed to the disintegrating agents* at the angles than at the sides, in proportion to the quantity of matter.

* These agents, water, air and change of temperature, when operating upon angular fragments, dissolve or crumble off these points with considerable rapidity. So that they will, in time, become rounded; if never rolled nor moved.

GEOLOGICAL SITUATIONS

OF THE USEFUL

MINERAL SUBSTANCES.

1. QUARRY STONES.

MARBLE	{	Granular and Compact limestone.
LIMESTONE FOR QUICKLIME.		

PRIMITIVE BUILD- ING-STONE.	{	Fine-grained granite.
		Slaty gneifs.
		Slaty hornblende rock.
		Soapstone, talcose rock.
		Serpentine.

TRANSITION BUILD- ING-STONE.	{	Argillaceous slate.
		Graywacke slate.
		Imbedded sandstone.
		Red sandstone.

PLAISTER OF PARIS	{	Gypsum.
ALABASTER.		

2. *COMBUSTIBLES.*

COAL. Above the position of Red sandstone, generally covered with bituminous shale or micaceous sandstone. It is frequently near Compact limestone.

PEAT. In alluvial, where vegetable substances are decomposed and mixed with earthy matter, bitumen, &c.

BITUMEN. Washes out of alluvial formations and forms a pellicle of the petroleum variety on the surface of standing waters. It is usually called mineral oil.

SULPHUR. It is mostly obtained from sulphuret of iron, which abounds in argillaceous slate, graywacke and some other rocks.

3. *PRECIOUS STONES.*

TOPAZ. In Granite and Gneiss.

EMERALD. In Granite.

RUBELLITE. In Granite.

SAPPHIRE	}	Probably all originally in Granite and Gneifs; but they are generally found in alluvion.
CORUNDUM		
EMERY		
RUBY.		

CHALCEDONY	}	In Superincumbent rocks and Alluvion.
CORNELIAN		
SARDONIX		
AGATE		
JASPER AGATE.		

JASPER. In Argillaceous slate, Limestone and Graywacke.

GARNET. In Granite, Gneifs, Hornblende rock, Mica-slate, rarely in red sandstone and limestone.

QUARTZ CRYSTALS. In all rocks; perhaps the most perfect in Argillite.

DIAMOND. In Alluvion. Note.—Though it is placed among precious stones it is pure carbon; of course combustible.

4. METALS.

GOLD. Mostly in veins of quartz in Granite Gneifs and Hornblende rock. Sometimes in Metalliferous limestone and Graywacke. It is found in sand of brooks in North Carolina; which sand is probably from gneiss rock.

PLATINA. In sands of rivers. As it is accompanied by magnetic iron sand, it is probably from Granite or Gneifs.

SILVER. Most in Metalliferous limestone. Also in Granite and Graywacke with lead.

MERCURY. In Argillaceous slate, Compact limestone with beds of bituminous shale, and in Alluvial clay.

COPPER. In Granite, Gneifs, Hornblende rock, Argillaceous slate, Metalliferous limestone, Red sandstone and Superincumbent rocks.

IRON. In all strata. Most at the Meeting of Mica-slate and Talcofe rock. Magnetic ore in Granite and Gneifs. Argillaceous and hematitic ore in compact limestone and alluvion. Pyrites is in all rocks, but most in argillaceous slate and graywacke.

LEAD. In Granite, Gneifs, Graywacke, Metalliferous limestone* and rarely in Compact limestone.

TIN. In Granite and Gneifs.

ZINC. In Granite, Gneifs and Compact limestone.

NICKEL. In Hornblende rocks and Meteoric stones.

COBALT. In Hornblende rocks and Compact limestone.

* See Schoolcroft's view of the Lead mines of Missouri.

MANGANESE. In Gneifs, rarely in Compact limestone.

ARSENIC. In Gneifs, Hornblende rock, rarely in Compact limestone.

BISMUTH. In Granite, Gneifs and Hornblende rock.

ANTIMONY. In granite, Gneifs, Hornblende rock and Graywacke.

MOLYBDENA. In Granite and Gneifs.

TITANIUM. In Granite, Gneifs and Hornblende rock.

TUNGSTEN. In Granite, Gneifs and Hornblende rock.

URANIUM. In Granite.

CHROME. In Talcofe rock and Granular limestone, connected with imbedded serpentine. It is in the state of an acid combined with an iron base.

ALLUVIAL DEPOSITES,

AS APPLIED TO

AGRICULTURE.

THE earthy part of soils being formed of broken and pulverized rocks, it depends entirely on the constituents of the rocks out of which it is formed. Therefore the study of rocks is essential to the study of soils.

But as various salts, as well as other materials, resulting from animal and vegetable decompositions, are intermixed with earthy soils, they become considerably complicated.

Soils may be very naturally divided into three parts. The gravelly and sandy part, the argillaceous part, and the soluble part.

1. The GRAVELLY and SANDY part holds no more water, than merely what adheres to the surface of the particles. It neither takes up, nor gives off, water with great rapidity. If the gravel be pretty coarse ; when moistened, it retains a moderate portion of moisture for a long time. Forming a loose porous soil, roots of vegetables are not compressed in it. But where this kind of soil is in excess, it is too loose to serve as a fit medium for transfusing the proper nutriment into the roots of vegetables.

2. The ARGILLACEOUS part absorbs a large quantity of water, with which it becomes combined throughout the mass. In wet weather it is much wetter and in dry weather much drier, than gravelly soil. Consequently roots of plants are surrounded with soft paste at one time, and compressed with a dry indurated mass at another. It follows that a due mixture of these two kinds of soil is very important to vegetation.

3. The SOLUBLE part consists of whatever may be dissolved or suspended for some time in water, at the common temperature. Most of these substances are nutrimentous, and are par-

tially taken up and devoured by vegetables. These are salts, as muriate of lime, muriate of soda, &c. carbonaceous matter, such as proceeds from decomposing culms and other parts of vegetables, as well as of animal matter, &c. This part of soils is transitory and requires to be frequently renewed.

In analyzing soils for practical use, these three kinds should be separated from each other, and carefully weighed. The agriculturalist will then be enabled to ascertain the deficiencies in either part, and will of course be enabled to judge respecting the application of a remedy. He must, however, take into view the quantity of moisture furnished by the situation of particular fields. A portion of soil should be selected from various parts of a field and from various depths; then duly mixed, so as to give an average specimen. This should be dried as much as it can be, without burning some dry pine sawdust, which should first be mixed with it; afterwards it should be carefully weighed. It must then be stirred in a tumbler of water, and afterwards permitted to stand about five minutes. The gravelly and sandy part will fall to the bottom;

the argillaceous part will remain suspended in the water so much longer, as to form a distinct stratum above it; the soluble part will remain in the supernatant liquid over the argillaceous stratum.

After the five minutes, pour the liquid part into another vessel: Then in more water stir up the gravel and argillaceous part again, and in a few seconds pour into another vessel the argillaceous part, while it is still suspended in water, leaving the gravelly part. Next evaporate each part to dryness, making it as dry as at first. At last weigh each part separately; which will give the proportions required.

Pulverized limestone is found to serve the double purpose of an earthy soil, and of exerting a peculiar action upon vegetables, somewhat analogous to the stimulant effects of gypsum. It will be found chiefly among the gravelly part, and may be detected by its effervescence with acids.

This method will give the proportions of the most essential constituents of soils, as it respects

their fertility. A minute chemical analysis may often be desirable; but such an analysis will rarely be of material use to the Agriculturalist.

The proportions of the gravel and sand to the alumine, in order to constitute the most suitable earthy soil, depends on the vegetables to be cultivated. Wheat requires a larger proportion of clay than Indian corn. Though the whole culmiferous tribe require more clay than the leguminous, cruciform or culinary tribes.

The best practical method for ascertaining the excellencies and defects of soils is, to analyze by this method, specimens of soils known to be good, and compare the results with the result of an analysis of the soil in question.

VEGETABLE NUTRIMENT.

Common marl, being a combination of clay and limestone, may be detected by its effervescence with acids. The richness of marls depends on the proportion of carbonate of lime in them. That part may be wholly decomposed by diluted muriatic acid, so as to form a limpid

supernatant liquid, leaving the clay as a sediment. It will therefore be perceived, that the proportions of these constituents may be readily ascertained.

The carbonaceous mixtures in soils serve while cooling to absorb nutritious gases from the atmosphere, and to give them off to roots of plants while warming. This is proved by every practical chemist, by passing charcoal, decomposed straw, &c. through mercury into the various gases, which furnish vegetable nutriment. Such as carbonic acid gas and ammonia; both of which are decomposed by vegetable action, and one or both of their respective constituents incorporated with the substance of living vegetables.

Though charcoal, remaining in coal-pit bottoms, endures for ages without material decay, always performing the office of absorbing and giving off the gases as before mentioned; yet loose carbonaceous matter, as that which results from the decomposition of straw, &c. is probably conveyed, in part, into the substance

of the plant. Consequently requires to be frequently renewed.

Though earthy matters are often taken up and conveyed into the substance of vegetables, they may be considered as accidental. No substance can be considered as food for vegetables, which cannot be brought to a liquid or gaseous state at the common temperature. The gypsum undoubtedly acts as a stimulus to the living principle ; exciting, as it were, the appetite of the plant to seize more greedily upon the nutritious materials within its reach. These materials being principally furnished by the atmosphere, (particularly the carbonic acid gas,) more carbonaceous matter is eventually added to the soil in the roots of clover and some other vegetables, in consequence of the stimulant action of the gypsum.

Moist earth absorbs the nutritious gases also. Such as ammonia, carbonic acid gas, carburetted hydrogen gas, &c. This is proved also by passing up dry, and damp earth, through mercury into different jars of the gases. This ex-

plains the cause of the great use of frequent hoeing and stirring the soil near plants ; particularly in dry weather. The dried surface will not absorb the gases which float in the atmosphere ; but the moist soil, which is presented to the atmosphere by hoeing, absorbs them with avidity, and presents them to the fine fibrous roots of plants.

ORGANIC RELICS.*

THESE fossil relics are of two kinds. PE-
RIFACTIONS and CONSERVATIVES.

* This article is chiefly translated from Martin's *SYSTEMA RELIQUIORUM*. Nothing more than a mere skeleton is offered; and that with a view to direct the learner one or two steps towards the arrangement of his collections.

It is but one year (March, 1820,) since any person residing in the interior of our district, had any *practical* knowledge of Organic Relics. A fortunate incident at length presented itself. The justly celebrated Le Sueur, the friend and companion of Cuvier, was called to Albany to perform some duties for the Commissioners for settling the boundaries between the United States and Canada. Being personally introduced to him by Professor Mitchill, who happened at Albany, I availed myself of the advantages of his instruction for four weeks. Though my stock of knowledge in this department of Nature is still very limited, I communicated all I knew to the members of the Troy Lyceum without delay. Being located in the vicinity of the Heldeberg, and other localities rich in these ancient treasures; very considerable advances have already been made by this institution. This sketch is intended to aid these inquiries in the most interesting part of Geology, until something better shall appear. A work on this subject is soon expected from John G. Bogert, Esq. of New-York, which will be adequate to the object.

PETRIFACTIONS, or SUBSTITUTIONS, are those relics, which are entirely made up of mineral substances, which have gradually run into the places occupied by organized bodies as those bodies decayed, and assumed their forms.

CONSERVATIVES, or PRESERVATIONS, are those relics, or parts thereof, which still consist of the very same substances, which originally composed the living organized being.

An organic relic may partake of both kinds. The shell of an oyster, being chiefly carbonate of lime, may still remain, which would be a *conservative*. While the enclosed animal matter will be entirely decayed and mineral matter occupy its place and imitate its form, which would be a *petrification*.

Organic relics are NAMED by annexing the termination *lithos* (a stone) to the scientific name of the living organized being. As *ichthyolithos* is composed of *ichthus* (a fish) and *lithos* (a stone.) That is, a fish becoming a stone. In English *lithos* is changed to *lite*, as *ichthyolite*. Sometimes the letter *l* is left out; as *lacerta*

(lizard) would make *lacertite* (a petrified lizard.) This abridged method has now come into general use.

In order to prepare ourselves for studying organic relics, we must attend to the classification of Animals and Vegetables, while in the living state. It is not necessary however, for the present object, to go very far into these departments of science.

I shall follow Martin in dividing all organic relics into nine Genera, eight of which belong to the animal kingdom. Much the largest proportion of remains belong to Linneus' sixth Class of Animals, which he denominates Vermes.*

* Martin's Genera of Animal Relics, nearly correspond with the Classes of living animals, excepting the Vermes. But he places all the vegetable kingdom in one genus.

ANALYSIS

Of Organic Relics.

When we undertake to ascertain the name of a relic, we first determine to which of the nine genera it belongs. Frequently we can go no further for want of perfect parts, whereby to ascertain the distinctive characters. Next we search for the characters on which are founded the family name, then the specific name. At last we search for the sub-species, if that species is subdivided.

We must always be careful to stop at that step in the series, where we are sure we have not mistaken the distinctive characters. For it is better to stop too soon, than to proceed to error. But we are not to expect all the characters perfect in any specimen. We must often judge from one or two marks.

The first five genera are so very rare in our district, (few in truth having been found at all)

that I shall merely give their generic characters and very short descriptions.

Genus I. *Mammodolite*.

The Prototype* is the separate bone or rarely entire skeleton of an animal of that class, whose young are nourished by the milk of the dam. Found in recent strata only.

Genus II. *Ornitholite*.

The Prototype is a separate bone or bill of a bird; very rarely an entire skeleton. Found in recent strata only; but rather older than the Mammodolites.

Genus III. *Amphibiolite*.

The Prototype is the bone of an amphibious animal; sometimes the skeleton is found entire. Sometimes it is a naked skeleton, and sometimes there is more or less of the remains

* Prototype signifies the original bone, or any other organized substance, of which the relic is a representative in form.

of the scales, crust or armoury. Generally in recent strata; but sometimes not the most recent.*

Genus IV. *Ichthyolite*.

The Prototype is a separate bone or the entire skeleton of a fish, often covered with the scales. Generally in recent strata, but sometimes not the most recent. Often in marl and bituminous shale.

Genus V. *Entomolite*.

The Prototype is the case or crust of an insect; sometimes entire and sometimes mutilated. Generally in recent strata; though sometimes even in the oldest secondary.

Genus VI. *Helmintholite*.†

The Prototype is a worm or its inherent parts, particularly the harder parts. Species of this

* The fleshy part of any animal of this genus, or of the two preceding genera, has never been found petrified. The petrified snakes, so often reputed to have been found, are *cornu-ammonites*, of the genus *Concholite*.

† I commence with this genus, and hereafter give a translation of Martin almost entire; because specimens of these four genera

genus are found in strata from the oldest transition to the most recent secondary.

This genus embraces most of those jointed, rugged, cylindric relics ; some of which resemble a spinning-wheel whirl, others appear like branching, jointed roots ; others are flattened or depressed and radiated or star-like.

N. B. *Species* of organic relics nearly answer to the *genera* of living prototypes.

STIPED FAMILY.

The SPECIES of this family have a kind of stem or stipe.*

PENNATULITE. The Prototype of this genus in the living state is the sea-pen. The body is solitary, elongated, stiped, (free†) pinnate,

are very abundant in our district. The French Naturalists have subdivided several of these species ; but I am not able to give their characters ; besides it is not necessary for this short outline.

* All the technical terms are defined in the Botanical Dictionary, published at New-Haven ; now in common use throughout our district.

† That part of the descriptions included in parenthesis, though found in living specimens, need not be sought in petrifications.

with a little inner bone (numerous little bones at the margin of the wings;) the wings are lateral, denticulate: stipe subulate.

ENCRINITE. Bodies radiated (a little mouth to each) and crowded together in umbels or whorls: the common stipe is simple and jointless, (furnished with a callous membrane.) The specimens are generally stait and resemble spinning-wheel whirls. Very common in the Heldeberg, also near Hudson and Catskill; particularly in the silicious sandstone, which accompanies compact limestone.

STYLASTRITE. Body most commonly radiated, (contractile, contracted) ovate or roundish, stiped, (mouth central) no aperture besides the mouth; stipe columnar, perforated lengthwise, (furnished with a central medulla) often sending off lateral branches (stone;) generally jointed, with crenulate futures.*

SUB-SPECIES. **ENTROCHITE.** Stipe terete,

* This species was taken from the species Isidite of the genus *Brismatolite* by Martin; leaving those jointed cylindric relics only, which are longitudinally striated between the joints.

with branches alternate, remote, and joints with circular grooves within ; disk radiate-striate : central ligament or perforation compounded from six filiform tubes, often producing a cavity obsoletely 5-lobed. It resembles knotted jointed roots. Very abundant in Bethlehem caverns at the foot of the Heldeberg.

SUB-SPECIES. PENTACRINITE. Stipe angular, branches in whorls : disk of the joints marked with stellate forms, composed of five crenate oval rays. The central perforation simple. Martin says, this and the preceding sub-species are found every where in lime strata ; but that entire specimens, unbroken, can hardly be found.

*SUB-SPECIES. ANTHOCEPHALITE.** Stipe long-turbinate, jointless, simple. Whether the body is five-cornered and five-toothed is doubtful. Found in the Heldeberg, but it is very abundant in Becraft's mountain near Hudson.

* Le Sueur labelled my specimens of this sub-species, Caryophilite. But Martin says, this name is given to a very different living genus of worms ; therefore he adopts this substitute.

STIPELESS FAMILY.

The SPECIES of this family are somewhat globular, or depressed like a flattened garden squash.

ASTERITE. Body depressed (coriaceous) often stellate, prickly, somewhat torulose: mouth central, having no other aperture.

ECHINITE. Body roundish (covered) crust bony, spiny (spines moveable): mouth below. I have seen a specimen found in Hunt-ville, in the state of Ohio.

Genus VII. *Concholite*.

The Prototype is a shell, produced by a molluscous or soft animal destitute of jointed limbs. Species of this genus are found in strata, from the oldest transition rocks to the most recent secondary.

This genus embraces the relics of proper shell animals; as of barnacles, oysters, snails, &c.

MULTIVALVE FAMILY.

The Prototypes of SPECIES of this family consist of shells of more than two valves.

CHITONITE. Valves often eight, rarely seven or six, transversely oblong, lying on the back.

LEPADITE. (Shell with the base affixed to some other body.) Valves many, unequal, erect; the little valves crowded together. The living prototype is called the *barnacle*.

SUB-SPECIES. BALANITE. Mostly sessile, conic, the aperture terminal (having a lid.)

PHOLADITE. Principal valves two, divaricate, with accessory irregular little valves, hinge recurved.

BIVALVE FAMILY.

The Prototypes of the SPECIES of this family consist of shells of two valves. Probably nine-

tenths of all the organic relics in our district belong to this family.

MYITE. Valves mostly equal,* unequilateral, often transversely ovate, gaping at either extremity. (The hinge, mostly, with one solid, thick, spreading tooth, not inserted into the opposite valve.)

SOLENITE. Valves mostly equal, unequilateral, oblong, gaping at both extremities. (Hinge with a subulate, reflexed tooth, often in pairs, not inserted into the opposite valve.) Austin Abbot, Esq. found one specimen near Hudson. It is now in the Troy Lyceum.

TELLINITE. Valves mostly equal, unequilateral, transversely ovate or suborbiculate, towards the forepart it is bent to one side. (Hinge with three teeth, the side of one valve flat.)

* Valves are *equal*, when they are similar in form and size; as the two sides of the common clam-shell. They are *unequilateral*, when what lies towards the edges on each side of the hinge is not equal; as the common clam-shell also.

CARDITE. Valves equal, somewhat equilateral, sub-orbicular, mostly very convex, longitudinally ribbed, striate or furrowed; margin toothed. (Hinge with middle teeth in pairs, alternating with each other in the opposite valves, one generally incurved.)

MACTRITE. Valves equal, unequilateral, transversely ovate, or three-cornered. (Hinge with the middle tooth folded in with an adjoining cavity, lateral ones inserted remotely.)

DONACITE. Valves equal, unequilateral, often ovate or wedgeform, margin mostly crenulate, very obtuse at the forepart. (Hinge with two teeth.)

VENERITE. Valves equal, unequilateral, often ovate orbicular, lips with a fore margin. (Hinge with three teeth standing near each other and diverging.) I found one in Blenheim in graywacke.

SPONDYLITE. Valves unequal, unequilateral, often suborbicular, rigid, sometimes a little auricled. (Hinge with two teeth, recurved, with an intermediate cavity.)

CHAMITE. Valves often subequal, mostly unequilateral, roundish, thick. (Hinge callous gibbous, inserted obliquely into an opposite cavity.) I found one specimen in the Heldeberg in the silicious sandstone.

ARCITE. Valves equal, unequilateral, oblong or roundish; hinge generally strait, rarely curved. (Hinge with numerous teeth.)

OSTRACITE. Valves unequal, unequilateral, not auricled, rough, mostly lamellated, not radiated, oblong, generally narrowing a little towards the hinge. (Hinge toothless.) I found one very fair specimen in the silicious sandstone in the Heldeberg; and I saw hundreds of a very large size at Glen's Falls in Saratoga county.

PECTINITE.* Valves auricled, radiated, equilateral; hinge strait. The strait hinge is

* Martin makes this a sub-species of Ostracite, following Linneus. But the French naturalists make it a distinct genus among living specimens; of course a distinct species among relics.

There are several varieties of Pectinites and Anomites in our district, which, for the present, may be distinguished by a descriptive adjective; as Cordate, Ovate, &c.

the best character in petrifications. Very abundant in the Heldeberg, Hudson, Catskill, Glen's Falls, &c.

ANOMITE. Valves unequal, equilateral; the point of one valve extending beyond the other at the hinge, either straight or incurved. The most common of all relics in the Northern states. In the Heldeberg it is often found very large. Sometimes the inside presents appearances, which are mistaken for tortoise shells, deer's hoofs, &c. by the common people.

SUB-SPECIES. GRYPHITE. One valve flatish, the other much curved at the hinge. With shallow rays or none. Very abundant in the Heldeberg.

SUB-SPECIES. TEREBRATULITE. Valves both convex, radiated with grooves, often large and deep, upper one becoming much narrower near the hinge and curved. Very common in the Heldeberg, Hudson, Catskill, Glen's Falls, on the shores of Lake Ontario, &c.

MYTILITE. Valves equal, unequilateral, obliquely or longitudinally ovate, rough. I found

one in graywacke in Blenheim, and Mr. Cyrus M. Stebbins found one near Hudson. Both are in the Troy Lyceum.

SUB-SPECIES. MARGARITIFERITE. Valves auricled, somewhat compressed; hinge strait, extended.

PINNITE. Valves subequal, unequilateral, erect, triangular, gaping, often rough-scaly.*

UNIVALVE FAMILY.

The Prototypes of the SPECIES of this family consist of shells of a single piece, as the snail-shell.

NAUTILITE. Shell chambered with perforated partitions, chambers numerous.

SUB-SPECIES. AMMONITE. Spiral, with the apex in the center, sometimes a little elevated, sometimes depressed. Found rarely at the Heldeberg, Lake Ontario, &c.

* At least three-fourths of all the organic relics constituting the Heldeberg, Glen's Falls in Saratoga county, and Becraft's mountain at Hudson, are Pectinites and Anomites with the sub-species.

SUB-SPECIES. RECTIUSCULITE. Strait a little distance, and spiral near and at the apex. Augustus Sacket, Esq. shewed me several large specimens found at Sacket's Harbor.

SUB-SPECIES. ORTHOCERITE. Strait from the base to the apex, and chambered all the way. This has the appearance of the vertebrae of animals. Very abundant and large near Lake Ontario. Common in the Heldeberg and sometimes found at Hudson. One was found in argillaceous slate at the north end of Troy.

SUB-SPECIES. BELEMNITE. Strait, elongated; having a conic chambered cavity at the base, but solid at and towards the apex.

SUB-SPECIES. TRILOBITE.* Base three-lobed; from the base to near the apex the body appears as if longitudinally divided into three rows of chambers. Called petrified miller by the common people when small; when large they consider it the petrified ribs of animals. Very abundant in Becraft's mountain near Hud-

* This sub-species is not described by Martin; neither have I seen a description of it. I drew this description from my specimens, which were labelled by Le Sueur.

ion, both in graywacke and compact limestone. It is frequently found at the Heldeberg also.

CONITE. Shell convolute, turbinate ; aperture effuse, linear, toothless, entire at the base, columella smooth.

CYPRAEITE. Shell involute, ovate, smooth ; aperture effuse at both ends, linear, toothed both sides.

BULLITE. Shell convolute, smooth ; aperture contracted, oblong, running lengthwise, entire at the base ; columella oblique, smooth.

VOLUTITE. Shell spiral ; aperture without any beak, somewhat effuse : no lip on the inner side of the aperture. We have received at the Troy Lyceum very minute specimens, in lenticular argillaceous iron ore, from the south side of Lake Ontario, presented by A. Cole, Esq.

BUCCINITE. Shell spiral, gibbous ; aperture ovate, terminating in a channel twisted to the right : inner lip spread, smooth. ↓

STROMBITE. Shell spiral, enlarged towards one side : aperture often with a spread brim, terminating in a canal turning to the left.

MURICITE. Shell spiral, prickly with membranaceous futures : aperture terminating in an entire canal, strait or somewhat ascending.

TROCHITE. Shell spiral, somewhat conic : aperture somewhat four-cornered, transverse above, contracted : columella oblique. A specimen was sent to the Troy Lyceum by the Rev. N. M. Wells, found at Sacket's Harbor.

TURBINITE. Shell spiral : aperture contracted, orbicular, entire. This species is often mistaken for the ammonite ; but it may be distinguished by its elevated apex and want of transverse partitions between chambers. Frequently found in the Heldeberg, near Hudson, at Glen's Falls, &c.

HELICITE. Shell spiral ; aperture contracted, lunate or roundish within, or the segment of a circle cut off. It is depressed, globose, ovate, or somewhat conic.

NERITE. Shell spiral, gibbose, flattish beneath : aperture suborbicular ; lip of the columella transverse, truncate, flattish.

HALIOTITE. Shell earform, spreading :

spire concealed, lateral: disk longitudinally perforated with pores.

PATELLITE. Shell subconic, without any spire.

DENTALITE. Shell tubular, free, perforated or pervious at both ends, without a spire, strait.

SERPULITE. Shell tubular, adnate, often contorted, entire at one extremity.

Genus VIII. *Erismatolite.*

The Prototype is the prop, support or habitation of a worm or kind of polypus, which was produced by itself. Found in all strata from the Graywacke to the most recent rock.

This genus embraces those relics, which, in the living state, are called Corals and Corallines.

CORAL FAMILY.

The SPECIES of this family have the support or habitation outside of the animal, and it is generally pretty thick and strong.

TUBIPORITE. Habitations tubular, stoney, often aggregated: tubes mostly connected by partitions, or tubular branches.

MADREPORITE. Support or habitation stoney: cells or naked habitations stellate with radiating laminae.

SUB-SPECIES. RETEPORITE. Surface presenting a checked net-like appearance. Found at the Heldeberg. I have no description of this; but my specimen was labelled by Le Sueur.

SUB-SPECIES. FUNGO-MADREPORITE.* (*Madrepora simplex.*) Support single: laminae in a single set of rays. Professor Silliman has a very perfect specimen; it appears like a common agaric, with a concave pileus or cap.

SUB-SPECIES. CORNU-MADREPORITE. Support with its lamellar longitudinal rays horn-form. Very abundant in the Heldeberg, at Hudson, Lake Ontario, &c.

* Martin says, this has been described by some authors as a petrified agaric: but that such a petrification has never been found.

SUB-SPECIES. ARBO-MADREPORITE. Stalk shrub-like.

SUB-SPECIES. CUMULO-MADREPORITE. Stalks united together, often forming an entire mass; sometimes they are more or less distinct.*

MILLEPORITE. Habitation stoney: cells in the form of pores. Often branched.

CELLEPORITE. Habitation somewhat stoney: cells cup-form. Very abundant in the Heldeberg and near Lakes Ontario, Erie, &c.

ALVEOLITE. Habitations stoney, covering other bodies, or in a simple mass, formed of concentric layers which are composed each of an union of numerous alveoles. The alveoles are very short, contiguous, reticulate and generally parallel.

FAVOSITE. Habitation stoney, simple, of a variable form; composed of parallel, prismatic, fascicled tubes, which are five or six-sided.† Called petrified wasp-nests. Very abundant in

* These may be considered rather as descriptive, than technical names.

† I took these two last descriptions from Say's excellent article.

the Heldeberg. Fascicular Favosite, is called a petrified knot at Lake Ontario.

CORALLINE FAMILY.

The SPECIES of this family have the support outside of the animal, and it is generally very slender and often branching.

SERTULARITE. Support often jointed (horn-like) shrubby, tubular: receptacles disposed often laterally, cup-form or teeth-form.

TUBULARITE. Support often jointed (horn-like) tubular: tubes continued or branched, often jointed: mouths terminal.

FLUSTRITE. Support often continued, foliaceous, composed of an united series of ringent cells.

CORALLINITE. Support jointed, often dichotomous (filamentose:) porous on the outside (calcareous.) Very abundant at Glen's Falls in Saratoga county. Perhaps a variety in

on Fossil Zoology in the American Journal of Science, pages 383 and 384.

red sandstone on Catskill mountains, in Blenheim near the head of the Delaware, &c.

CRUSTY FAMILY.

The Prototype of this family consists of a woody or stoney stalk, covered with a bark-like crust.

ISIDITE. Support (stoney) shrubby, jointed between the knots; joints longitudinally striated. I found one imperfect specimen in the Heldeberg. Capt. Dowd presented a small, but very well characterized, specimen to the Lyceum, from near Genesee river.

GORGONITE. Support (woody, testaceous or horn-like) shrubby, continued.

FAMILY DOUBTFUL.

ALCYONITE.* Support is a proper stipe, with a pileus or cap composed of radiating tubes. In form it resembles a stiped agaric. One specimen found in Bethlehem cavern by Mr. A. P. Heartt was presented to the Troy Lyceum.

* This species was labelled by Le Sueur. As I cannot procure the French description, I am compelled to describe it from the external appearance of the specimen. This may serve until something better appears.

Genus IX. *Phytolite*.

Prototype some part of a plant ; either root, trunk or leaf.

MUSCITE. Some part of a moss. Stem distinct, filiform : leaves simple, generally crowded together, imbricate, sessile.

FILICITE. Some part of a Fern. Leaves mostly pinnate or pinnatifid. Very fine specimens found at the Rhode-Island coal mines.

GRAMINITE. Culm mostly jointed : leaves simple, lance-linear. The culms of an unknown species of grass I found in the Heldeberg, in silicious sandstone.

PALMITE. Body of the stem or root simple with the apex leafy.

LIGNITE. The body or limb of a tree. We have excellent specimens from the Mobile in the Troy Lyceum. Also tolerable specimens embraced in calcareous tufa from near the west boundary line of Madison county, N. York.

RHIZOLITE. Any part of a root. We have a specimen in the Lyceum, embraced in calcareous tufa from the same locality as the last above.

INDEX

TO THE

Geology of the Northern States.

I. PRIMITIVE CLASS.

STRATUM 1.

GRANITE.

*Spencer Range.**

THE granite of the Northern States may be divided into five ranges. This will not embrace the granite of the State of Maine, nor the short patches near the eastern shores of Massachusetts above and below Boston Harbor.† A

* I shall distinguish the ranges by the names of the towns through which they pass in the line of our section; which is laid, so as to average a few minutes north of the 42° of N. Latitude. A very broad belt, from ten to forty miles is taken into view for fixing the order of strata.

† Messrs. Dana say, that no formation of granite is found in the vicinity of Boston.

faithful view of these ranges, however, will be abundantly sufficient for presenting the science of Geology, in that elementary form, which is intended in this Index.

The broadest and the most uniform in its breadth of all the five ranges given in our section, is that which passes through the town of Spencer, Mass. The White Hills of New-Hampshire, which M. Rafinesque calls the Nucleus of New-England, belong to this range. The extent of the granite, in that vast pile of mountains (which has not yet been traversed by a Sauffure) is not ascertained. From the best observers we learn, that it is principally Gneiss.

This range commences on both sides of Connecticut river at its mouth. Inclining a little easterly, it leaves that river to the west, near the north bounds of the town of Haddam. It holds a great breadth as it extends northerly through the towns of Bolton, Stafford, &c. Con. Brimfield, Sturbridge, Spencer, &c. Mass. On its course through New-Hampshire to Canada it varies its breadth considerably. Sometimes approaching near to Connecticut river; at oth-

ers leaving considerable breadth for the transition and secondary classes on its eastern shore.

Wherever I have examined this range it is generally very coarse-grained and of the grey variety. Though elegant specimens with the flesh-coloured felspar frequently occur. In Haddam the felspar is of a beautiful pearly white ; and often in blocks of more than a foot in extent. The mica is variously coloured, and frequently very beautiful.*

At Saybrook Professor Silliman found well-characterised specimens of lamellar sulphuret of molybdena in this rock. In Haddam Col. Gibbs and Mr. Silliman have discovered vast quantities of beryl, some emerald and chrysoberyl. Mr. Mather found a crystal of beryl here nine inches in diameter. I collected here about fifty elegant specimens of beryl, some of them very large, one fine specimen of emerald and considerable chrysoberyl, for the

* My son, A. B. E. found at Haddam a specimen of silver-coloured mica with a jet-black belt traversing the same plates. Also a mass of hexahedral crystals of mica two inches in diameter, with four of the sides perfect and unbroken. They are now in the Troy Lyceum.

Troy Lyceum, notwithstanding many cabinets had previously been supplied from the same locality.

In Brimfield I found the most beautiful adularia substituted for felspar in both granite and gneiss. Small four-sided crystals of zircon, terminated by four-sided pyramids, of the colour of smoky quartz were found in connexion with the adularia in a wall near the residence of the late General William Eaton, by his daughter.* Lamellar scales of plumbago are often disseminated in granite and gneiss in Brimfield and Sturbridge; and Dr. A. Lincoln found sulphuret of molybdena in granite in the western part of Brimfield. In the White Hills of New-Hampshire at Rosebrook's Gap, Col. Gibbs found green fluato of lime.

Throughout the whole extent of this range, as far as I have examined, it passes laterally under the gneiss both to the east and west.

* Jameson found zircon in gneiss. See Bruce's Journal, page 261. And I have one specimen of gneiss found in Brimfield containing zircon.

Shrewsbury Range.

Proceeding easterly, the granite appears again in Shrewsbury, east of Worcester. This range is remarkably fine-grained, and of a light grey colour. It yields to the chissel so readily, that it is much used for building-stone. It extends into New-Hampshire across the Merrimack river ; down which and the canal vast quantities are transported to the State-Prison, where it is manufactured by the convicts for the Boston market. It has now become so common for buildings, flagging side-walks, street-posts, pillars, &c. in the town of Boston, that an eastern traveller, on visiting it, might fancy himself transported to Grand Cairo in Egypt.

This range sinks under the gneiss towards the eastern part of Shrewsbury and does not rise again west of the Atlantic, in the course of our section.

Northampton Range.

Returning on our section to the west, the granite sinks under the gneiss near the eastern

part of Brookfield. It appears frequently in deep vallies at various intervals much farther to the west. There is one direction, where the granite of the Spencer range, can be traced along under the other strata and under Connecticut river, entirely into the Northampton range. Though it cannot be seen all the way, we fall in with it at such intervals and in such relations, that the most sceptical will not doubt. The best course for this examination lies from Brookfield northwesterly to Leverett, thence to Whately and Williamsburg. The gneiss and the higher strata cover the granite, excepting in the deep valleys and at other low levels. It disappears entirely for a little distance, when it passes under the secondary strata and under Connecticut river.

The Northampton range commences in the state of Connecticut and may be a branch of the Hinsdale range; or rather this and the Hinsdale range probably spring from the same root west of New-Haven. I have no doubt but the granite at Canton in Connecticut belongs to this range. I have traced it from near Connecticut line in Southwick along the west bounds

of Westfield, near the east bounds of Montgomery and the west of Southampton, near the west bounds of Northampton, and into Hatfield and Whately. Here it disappears by dipping under the higher strata; and it is supposed to rise again near the south line of Vermont.

Although I do not intend to account for any of the errors of the first edition of this Index, but to present facts as I now understand them; yet as a range of granite passing through Chesterfield has been adopted by many learned American geologists, it will be expected that I should give my reasons for this innovation.

After examining the granite in Chesterfield and Goshen very attentively, I find that it is always in the form of veins traversing gneiss. The large mass in Chesterfield village, which seems to have given character to the whole supposed range, is certainly a mere vein, enclosed by distinctly characterized gneiss walls. This subject requires no train of reasoning; I assert the fact and invite geologists to countenance or contradict me, after inspecting the rock. Even the vast bed of granite two miles northwesterly

from Chesterfield village, mentioned by Col. Gibbs* as traversed by "a false vein of silicious felspar and quartz," is itself a vein traversing gneiss. Col. Gibbs says, the bed of granite in Goshen, six miles north of Chesterfield, which contains the blue tourmaline, rose mica, &c. has not been discovered. If the range of loose rocks in which they are found be pursued northerly a considerable distance, I think it becomes pretty evident, that those fragments proceeded from a vein in gneiss. Though I confess we are compelled to reason from analogy in a great measure.

I have observed, that veins of granite, when found in gneiss, abound in tourmaline, and the fairest specimens of mica, and often contain beryl. Such is certainly the fact in Haddam and Litchfield, Con. and in Chesterfield and Goshen, Mass. While the oldest granite, as that in the Spencer range, presents but few specimens of tourmaline, and the mica is generally of but one variety.

I had much difficulty in adjusting primi-

* See American Journal of Science, page 348.

tive rocks in New-England in systematic order, while I considered those vast veins as indicating the place of granitic strata. But since I have attempted to separate veins from strata, all the difficulties are obviated.

I will point out to the reader another locality, which I think will very clearly illustrate this position. In Goshen, one mile east of the blue tourmaline locality, mentioned by Col. Gibbs, in an open field, a little to the south of a Beaver-pond, is a gneiss rock, laid bare to a considerable extent. Here is a vein of very coarse grey granite, fair to the view, from six to twelve feet wide with almost an even surface, and several rods in length; vertical and embraced between walls of very distinctly characterized gneiss. Veins of this kind, though not of equal extent, appear near Leicester Academy; also traversing hornblende rocks in Belchertown.*

* Extract from a letter to Dr. A. Robbins, the Corresponding Secretary of the Troy Lyceum, which I wrote, while acting as Collecting Agent—dated Danbury, Con. Nov. 19, 1818: "Much is yet to be done, before even the outlines of the Geology of this country is settled. Among other subjects the granite itself seems to be too incorrigible to submit to the Wernerian arrangement. After I am better prepared I intend to remark extensively upon

This range seems to lie very near the surface. For it frequently appears in large patches where the upper strata seem to have passed away. Dr. David Hunt, who has every mineral in this part of the state at his call, conducted me to a quarry of the fine-grained granite, but a small distance westerly from Northampton village.

The lead mines of Southampton and Hatfield are in this range. Mr. Hitchcock found lead ore, with most of the accompanying minerals which are found in the Southampton mines, at Whately and Leverett. This affords one of the best evidences, that this range of granite passes under Connecticut river, supporting the upper secondary and alluvial formations.

Where this range passes along the west bounds of Westfield, four miles west of the Academy, in the woods north of the Ruffel road, I discovered a very extensive bed of serpentine, em-

this stratum. At present I am compelled to state, that wherever I have examined, it appears rather in veins traversing gneiss and hornblende rock, than as a distinct stratum. I do not feel inclined to any such new doctrine. I merely intend to confess, that after much minute investigation for three years past, I am still embarrassed with this part of the system of arrangement "

braced in granite. It is exactly upon M'Clure's Springfield geological section. The surface of the serpentine exhibits the destructive effects of disintegration. But on examining it in the fissures, it appears to be sufficiently compact for quarrying. I have no doubt it will, at some future day, become a profitable quarry. Towards the south end of the bed, beautiful talc is very abundant.

In the lead mines of Southampton, Dr. Hunt, Col. Gibbs, Professor Silliman and Dr. Meade have found many interesting minerals. Sulphate of barytes, sulphuret of zinc, sulphate of zinc, sulphuret of copper, sulphuret of lead, sulphate of lead, muriate of lead, molybdate of lead, fluuate of lime, beautiful radiated quartz, &c. Most of these minerals have been discovered at Hatfield also. Mr. Silliman observes, that this vein extends from Montgomery to Hatfield, a distance of twenty miles. Bruce's Journal, page 64. Mr. Hitchcock has now traced it to Whately and across Connecticut river to Leverett. I have traced the same granitic range and found it embraced similar imbedded minerals, nearly to the south bounds of

the state of Massachusetts. Although I discovered no lead so far south; I think, from a consideration of the minerals with which the lead is associated, that it is probable the vein extends nearly across the state of Massachusetts, and perhaps farther.

Hinsdale Range.

Proceeding to the west, the Northampton range of granite passes under the gneiss, and appears again near the foot of the mountain of Peru on the west side, in the town of Hinsdale. Here as well as at Northampton we have a specimen which is fatal to that part of Werner's theory, which requires that the granite should be the highest in similar situations. The granite supports the gneiss on its eastern side, several hundred feet higher than itself. A similar relation between these two strata is presented in Saratoga county, which will be described hereafter.

The Hinsdale range of granite commences on the west side of Housatonic river, a little north of Bridgeport, in Connecticut, and extends in a

northerly direction, probably uninterrupted, until it passes the bounds of Canada. I have traced it through most of Litchfield county, and find it passes out of the state through Norfolk. I have pursued the same range across Massachusetts ; and Dr. Edwin James has traced it thence most of the way to Canada. It is very strange, that several publications have located the southern extremity of this primitive range in West Rock, at New-Haven ; which is greenstone resting on red sandstone. Such random guesses, given as facts, are very injurious to the science.

Most of this and the Northampton ranges are remarkable for being at a lower level than the gneiss and hornblende rocks. Sometimes they are even lower than the mica-slate and talcose rock. It presents all the varieties of colour and texture. In Litchfield county, Conn. we find the felspar pearly white and bright flesh red. Also the most beautiful specimens of graphic granite ; particularly in the town of Bethlehem. Where it crosses our section at Hinsdale the felspar is generally dirty white. In Adams, twenty miles north of Hinsdale, the

quartz is purplish blue; and sometimes the felspar is a bright blue. Fragments of the latter variety have been found, of several hundred pounds weight, in the alluvion near Troy; more than thirty miles out of place.

Near the southern extremity of this range, in the town of Huntington, Con. Mr. Silliman found in it, tungsten, tellurium, native bismuth, &c. In Litchfield county, Mr. John P. Brace conducted me to localities, where it contained beryl, smoky quartz, tremolite, chalcedony, petrosilex, fluor, &c.; but the principal rock in this county is gneiss, and it generally contains similar minerals to those found in granite. In Woodbury it contains magnetic iron pyrites, and in Roxbury carbonate of iron; though probably the latter mineral is in a vein of granite in gneiss.

I have seen several very interesting minerals from this range in the state of Vermont. But little authentic account of particular localities has been received. Dr. Edwin James presented to the Troy Lyceum an aggregated mass, from this range in the town of Charlotte, of pearly

white felspar, whitish quartz, green augite, green and red coccolite and laminated plumbago. This had been long ago discovered by Professor Hall as the locality of coccolite; and it seems that the celebrated Rogers' Rock is chiefly a mass of a similar aggregate. But I had never before seen such large crystals of green augite. Dr. Wells received a specimen from Rogers' Rock containing one slender transparent crystal. He also received, and presented to the Troy Lyceum, a specimen of native bismuth, which was picked up in a small creek near Ticonderoga. This probably proceeded from one of the granite rocks in that vicinity. But whether from the eastern or western range, it is difficult to determine.

The granite of New-York Island has never been traced, to my knowledge, so far as to ascertain to which range it belongs. Whether it is an interrupted spur from the Hinsdale range, diverging from it in the southwest part of Connecticut, or insulated and independent, I can at present obtain no means of determining. It seems to be accompanied by gneiss, sienite, mica-slate, talcose rock, granular limestone, &c.

It presents several varieties. Dr. John Torrey has shown me specimens of the red and grey; and the Rev. F. C. Schaeffer found the graphic variety.

Saratoga and Highland Range.

The Hinsdale range of granite sinks laterally under the gneiss to the west. All that part which is included between Vermont and Litchfield, Con. never rises again this side of the Rocky Mountain at the head of the Missouri. Whether it rises again this side of the Pacific ocean we are not able to determine at present; as we have not yet received any satisfactory account of the Rocky Mountain.*

I say that part, which is included between Vermont and Litchfield; because Dr. Steel has treated the Saratoga, and Highland, granite as the same range.† And as I can see no incon-

* We shall no longer remain ignorant of the constituent strata forming that mountain, after Dr. Edwin James, and Mr. Henry R. Schoolcraft, who are attached to the western scientific expedition, shall have set foot upon it.

† See Steel's Analysis of Mineral Waters, 2d Ed. page 20

venience in such a view of the subject, I shall follow him.

This is the most extensive range in North America. It commences, according to M'Clure, in Georgia. It continues, with little interruption, through all the states in its course northeasterly, as far as Dutchess county in the state of New-York. There it sinks gradually beneath the upper strata and rises again one mile north of Saratoga Springs. Thence it continues on with but few interruptions into the unexplored regions of Upper Canada.*

The appearance of the granite in Saratoga county is very remarkable. Without a view to any particular theory, its appearance may be represented by the following supposition. That all the strata now in view formerly lay in a horizontal position; with the granite at the bottom

* Perhaps future investigations may prove the Highland range to be more properly united to the Hindsdale; and that the northern part which extends down from Canada, terminates at Saratoga. This is M'Clure's plan, as laid down on his Geological Map; though he does not profess to be minute in the minor localities. An accurate geologist ought to explore the country from the Highlands to Salisbury mines; and from New-York Island to Danbury, in Connecticut.

and the compact limestone at the top, covering the whole country. That a force was applied beneath the granite, sufficient to raise it up with all the upper strata on its back. But at this place it happened to break through them all at once, forming a north and south fissure of thirty or forty miles in extent. All the strata on the east side of the fissure fell back nearly entire, and still remain so; with the compact limestone covering the whole as it did while all the strata lay undisturbed. But on the west side the strata still retain the elevations to which they were raised. For about ten miles from the south extremity, the granite shows only its eastern edge, and that but a few feet higher than the eastern plain; while it supports the gneiss, hornblende rock and mica-slate of such thickness, as to form over it a mural mountain. Wherever the rock is laid bare on the east side of the supposed chasm, it is compact limestone; which in some places meets the granite so closely, that it may be compared to a board scribed up to a wall by a carpenter.

Where the river Hudson cuts through the mountains, about twenty miles north of Sara-

toga, near Glen's Falls, the granite rises much higher. Here, at its eastern base, the compact limestone, consisting mostly of organic relics, is washed bare by the river. A teacher of Geology might here arrange his pupils, so that they might inspect specimens in place of the primitive, transition, secondary and alluvial classes, on a vast scale. And at the same time they might all sit within the sphere of his voice, but for the roarings of the mighty Hudson, rushing down from the ancient granite to the recent formations below.*

Lamellar scales of plumbago are disseminated through the granite at a place about seven miles north of Saratoga Springs. In a hole dug about ten feet into the solid granite, the walls presented a beautiful glimmering appearance, caused by the dissemination of scales of plumbago.† I believe molybdena has been

* For the geology of Saratoga county, with a complete geological map, the reader is referred to the Introduction to Dr. Stecl's *Analysis of Mineral Waters*, 2d Ed. published at Albany.

† This hole was dug by a deluded company of money-diggers. About half a dozen robust young men were at work when I visited the place, Dec 1818. They were encouraged by one of those impostors, who pretends to see hidden treasures by looking into

found here also ; but I lost my specimens before I tested them. The felspar is generally white, and I found a few specimens of adularia. Cubic masses of magnetic oxyd of iron are not uncommon.

At the Highlands the granite embraces large beds of very hard serpentine. The granular magnetic iron ore, containing small crystals of yellowish phosphate of lime, is abundant in the Highlands, embraced in both granite and gneiss. I believe every known variety of granite is found here.

I have been able to ascertain but few localities of disseminated minerals at the Highlands. Neither have I learned in which particular strata the many minerals brought from there were found. Mr. S. W. Conrad found crystals of zircon in this range, where it passes through New-Jersey. I have seen crystals of beryl in granite paving stone, which were brought to Albany from the Highlands ; but know nothing of the particular localities of them.

a magic mirror. When I attempted to convince them of their error, their magician told them that I wished to persuade them to desert, that I might come and take the treasure.

It has been the received opinion, that there was no granite west of this range in North America ; or at any rate not on this side of the Rocky Mountain. But it appears from the observations of Mr. Henry R. Schoolcraft, that there is a low range of granite, resembling the Northampton range, of a similar variety and containing similar minerals, on the west side of the Mississippi, passing northerly perhaps through the state of Missouri. The lead mines, with the accompanying minerals, blende, sulphate of barytes, fluor-spar, radiated quartz, &c. are found in the course of this range for seven hundred miles.*

* See Schoolcraft's View of the Lead Mines of Missouri, pages 92, 118 and 193.

STRATUM 2.

GNEISS.

DESCRIPTION.

THIS is the most extensive of the primitive strata in our district.* Bakewell says, it is scarcely known in any part of England or Wales; but that it constitutes the principal rock formation in a considerable part of Sweden. It is rarely wanting in its place in New-England; though there are such localities of limited extent.

Ranges between Spencer and Shrewsbury.

The Spencer and Shrewsbury ranges of granite being but about twelve miles asunder in our section, none of the intermediate strata are very extensive. The gneiss, however, immedi-

* Gneiss in the primitive class, graywacke in the transition and compact limestone in the secondary, probably form the basis rocks of three fourths of North America.

ately adjoining the Spencer granite, is about five miles in breadth. Both to the north and south it spreads out and becomes very extensive. The White Hills of New-Hampshire are said to be chiefly embraced in it. And it spreads over from twenty to thirty of the towns in Connecticut, lying between Thames and Connecticut rivers. In almost every part of this range, the granite appears in the deep valleys, while the gneiss covers the eminences; though sometimes the sienite crowns the highest hills. It is very hard and compact near the granite. On the eastern declivity of the hills towards Worcester, it becomes tabular, straight-grained and fissile; in some measure resembling the gneiss quarries in Haddam, Con.

Passing under the upper strata between the villages of Leicester and Worcester, it rises again towards the highest part of Shrewsbury. Here it is of very little extent, being soon cut off by the granite; and I have remarked nothing here peculiar in its character. It is said to embrace a bed of plumbago near Worcester, but I did not visit it, and have no conclusive evidence of its being in this stratum.

Range east of Shrewsbury.

The gneiss commences in the eastern part of Shrewsbury and continues to the foot of the hill west of Framingham. There are several valleys, at the bottom of which we find granite. Some of the hills present fields of hornblende rock in their highest parts; and patches of mica-slate sometimes, though rarely, occur. The alluvion hides the rocks to considerable extent near the stage road; but on examining the country north and south for several miles, I became convinced that gneiss is generally the basis rock. I found several beds of calcareous sandstone, which induced me at first to consider it a stratum analogous to one of the ranges of granular limestone west of Hinsdale. But I have since become familiar with such beds. I find them very nearly resembling sand-like limestone aggregated with quartz, imbedded, for miles in extent, in the gneiss of Saratoga. Bakewell and other European geologists, mention the occurrence of similar aggregates in gneiss.

Near Framingham this range passes under distinctly characterized hornblende rock. It

does not appear again as the principal rock, in the eastern part of our section.* But the three lower primitive strata seem to lie nearly in a horizontal position, the lowest of which being at no great depth, throughout the whole extent of country from Shrewsbury range of granite to the Atlantic. For wherever we descend into the deepest valleys, we reach the granite, with gneiss and hornblende rock resting upon it in succession, in almost every part of this portion of our district. In truth there are several extensive tracts of country in the New-England states, where these three strata, and sometimes two or three of the next in succession, may be distinctly seen lying upon each other, as we ascend from valleys of moderate depths to the tops of adjoining hills. Here we are relieved from all the uncertainties of theory. For we actually see a succession of eminencies, in which the strata now retain their original order; while the uppermost are cut off by the intervening valleys. Monson, Ware, and Belchertown, pre-

* Messrs. Dana mention porphyritic granite in a range of towns (Cambridge, Newton and Needham) from northeast to southwest, near Boston. It is denominated porphyritic gneiss in this work, and occurs in Western, Litchfield Co. &c. See *Geology of Boston*, page 80.

sent excellent illustrations of this position, as well as many towns between Shrewsbury range and Boston.

Ranges between Spencer and Northampton.

The gneiss commences near the east bounds of Brookfield, as we return to the westward along our section. It is difficult to fix on the west limits of this range. It appears to be the principal rock in all places, excepting the very lowest, as far as the west bounds of Western. Beyond that place, the highest hills are capped with hornblende rock ; but gneiss is the principal rock as far as Swift river. In the deepest valleys granite appears as far west as Belchertown, with the gneiss between it and the hornblende rock. Near the Forge, one mile north of Belchertown meeting-house, is a striking locality.

That part of this range, which lies between Chicapee river and Coy's hill, is porphyritic gneiss.* It is curiously spotted with cubes and

* It is very extraordinary, that some American geologists should denominate this rock porphyritic granite. Wherever it

parallelopipeds of felspar, of the granular variety. I have seen thousands of these blocks from two to four inches long and from one to two inches wide. This variety of gneiss runs southerly through Brimfield; but it is not so broad as in Western.

The gneiss of Brimfield, Sturbridge and Stafford contains in some places, large quantities of very soft sulphuret of iron. This substance, when exposed, is continually subject to chemical decomposition; and sulphate of iron is produced. Several chalybeate springs in Sturbridge owe their sulphate of iron to this cause. The Stafford waters are well known. They also derive their chief qualities from the same source.

Near the boundary line between the towns of Sturbridge and Holland, there is a large bed

occurs within the course of my observation, it is the most perfectly characterized gneiss. In Western, and in Litchfield county, Con. it is decidedly the uppermost layer of the gneiss stratum. It is true, that the European books speak of porphyritic granite; but they define true fine-grained granite. If they really meant this rock I could not servilely follow them against the indisputable dictates of common sense; notwithstanding my high respect for some of their authors, borders on veneration.

of plumbago (carburet of iron) between extensive layers of gneiss, which was wrought many years ago. A shaft of 107 feet was sunk here and many tons were taken out. In connexion with this is an extensive bed of hornblende, not aggregated with any earthy substance; but arseniate of cobalt is disseminated through it in small quantities. It has no connexion with any hornblende rock; but is a mere insulated homogeneous mass.

In Brimfield the gneiss contains very beautiful pearly adularia, sometimes connected with small crystals of zircon. Laminated plumbago is very frequently disseminated throughout extensive rocks.

This range is not very extensive near Connecticut river in Chatham and Haddam. In Haddam it is in vertical tables, where it is quarried to a great profit. Large quantities from this quarry are transported by water to Albany, Troy, and other river towns, to be used for flagging. The veins of granite, so rich in beautiful crystals of beryl, horn, &c. traverse the gneiss of this quarry.

This range varies greatly in breadth on the north side of our section, as well as on the south. Accompanying the Spencer range of granite into Canada, it stretches over four or five degrees of latitude with very little interruption. Col. Gibbs found beds of magnetic iron ore in it, in several places in New-Hampshire. But like other strata running through New-Hampshire, as well as Vermont, it has not been duly examined far to the north.

This range evidently passes under Connecticut river, accompanying the granite and covered with other strata, and rises with it on the western side. As far, however, as I have examined this range, it seems to be chiefly broken up into patches of little extent. These patches are not unfrequent, and generally rest immediately upon the granite.

Ranges between Northampton and Hinsdale.

To avoid being misled by theory, has ever been an important consideration with me, from the commencement of my geological researches. "Lead me not into temptation," should be the prayer of every honest geologist. For theories

are so fascinating that perhaps none can effectually resist them. With all my determination I cannot shut from my fancy that theoretic vision, which presents this gneiss rock, commencing on the west side of the Northampton range of granite, accompanying and concealing the granite in one continuous stratum through to Hinsdale. Though it is itself covered with other strata most of the way through Worthington and a part of Peru, I cannot but consider it as the same stratum, presenting its eastern and western edges at Williamsburg and Hinsdale.

The eastern range constitutes most of that range of hills, or rather mountains, which runs through Goshen, Chesterfield, part of Williamsburg, Norwich, Montgomery, Russell, Granville and Hartland. I have traced it in all these towns to my entire satisfaction; and I presume the gneiss near New-Hartford village belongs to this range. It seems to disappear, or at least to become rather uncertain, near the north bounds of Williamsburg and Goshen. Most of this range has its layers considerably curved, and nearly in a vertical position, like all the other ranges of this stratum in New-England.

Several interesting minerals have been discovered by Dr. David Hunt and Col. Gibbs in veins traversing this rock. One new mineral, silicious spar,* is found in great abundance two miles northwest from Chesterfield village, also in Goshen five or six miles further north. With the silicious spar of Chesterfield is found beautiful green tourmaline and beryl. With that of Goshen is found blue tourmaline, or indicolite, rose and yellowish-green mica.

This range sinks laterally under the upper strata, and appears again a little to the east of the highest part of the mountain of Peru. Almost the whole of this mountain is gneiss. It extends northerly into Vermont, increasing in breadth. It forms most of those gigantic piles, which sever the divisions of the south branch of the Deerfield river; and the highest part of the mountain east of Adams, called Hoosack mountain. It is remarkably hard and harsh.

* Soon after Dr. Hunt discovered this mineral, Col. Gibbs pronounced it a new one, or a new variety of felspar. But Professor Haussman first analyzed it. It consists of about 71 per cent siliceous, 20 alumine and 9 potash—sometimes a very little lime, magnesia and iron. Felspar contains from 12 to 14 per cent potash instead of soda. See Am. Jour. Science, page 348.

The position of its layers almost vertical, and often much undulated.

It maintains its breadth southerly, spreading over a large portion of Litchfield county in Connecticut, as well as the northwestern part of New-Haven county.

Range west of Hinsdale.

All the strata between the Hinsdale range of granite and the argillite, are remarkable for their frequent alternations ; or, perhaps more properly, their anomalous relations. I shall treat them, however, according to the order, which is so clearly presented to us, every where to the east of this range. But I shall not omit to notice all the local deviations from that order, which have fallen under my notice. Fortunately I have had a better opportunity to examine this part of our district than any other part ; excepting the transition class in the state of New-York. In addition to this advantage, I have had the assistance of that very able and accurate naturalist, Professor Dewey of Williams College, for two or three years. He re-

fides at the very central point of the most complicated difficulties ; and never suffers any interesting fact to escape his notice.

This range of gneiss is separated into two layers, from near the south boundary line of Massachusetts far into the state of Vermont, by a broad layer of granular limestone connected with granular quartz. The layer next to the granite is thin ; and at some places seems to be interrupted. It is generally low and rests laterally against the granite. It passes suddenly under the very thin, though distinctly characterized, stratum of hornblende rock ; over which lies the granular limestone.

The other layer, beyond the first range of granular limestone, forms the principal part of a range of high mountains. This layer of gneiss, together with the mica-slate, talcose rock and granular quartz, constitute Saddle Mountain, twenty-four hundred feet* higher than the granular limestone, and several hundred feet higher than any mountain in Massachusetts or Con-

* See Professor Dewey's Geology of Williamstown, Am. Jour. Science, page 337.

necticut. This mountain range crosses the state of Massachusetts and runs into Vermont. But it is cut down transversely entirely to a level with the limestone at Williamstown and Pittsfield; and almost as low near Stockbridge.

Near the south bounds of Massachusetts, the eastern and western ranges of granular limestone, which run along both bases of this range of mountains, unite, and entirely insulate it; or render it a peninsula.

Opposite to the south end of this range of mountains, the layer next to the granite begins to extend in breadth, and soon becomes of considerable extent. Passing southerly through the state of Connecticut, it forms several lofty hills, which may be denominated mountains.

Mr. Brace has found plumbago in it and several other minerals common to this rock, in Litchfield county. In the peninsular part, three miles northwesterly from the village of Great-Barrington, I found a bed of oxyd of manganese combined with much oxyd of iron. Possibly this bed may be worth noticing; but I

had no leisure to pursue the enquiry. It is on M'Clure's Springfield section.

Ranges of Saratoga and the Highlands.

The gneiss accompanying the Saratoga range of granite lies wholly on its western side. For an explanation of this arrangement of the gneiss, the reader is referred to the article on the granite of this range.

This is that variety, which is denominated, the most recent formation.* Its position is nearly horizontal, and its layers rarely undulated. In an analysis of this range, we need not resort to any train of reasoning or analogy, to arrive at facts. For the river Hudson having cut a transverse section through it, seven or eight hundred feet in depth, we can examine all its layers, and its place of meeting with the granite, as we would inspect a map.

Near the commencement of the gneiss upon the granite, it dips a little to the west. But it

* See the introduction to Dr. Steel's Analysis of Mineral Waters.

is almost perfectly horizontal in the mountain Kayaderoferas which it constitutes about eight miles west of the granitic ridge. The extent of this range of horizontal gneiss I have not been able to ascertain. David Buel, Jun. Esq. 2d Vice-President of the Troy Lyceum, examined it about twenty-five miles west of its eastern edge;* and Major James Dalaby, the 1st Vice-

* Extract from a paper which was read by Judge Buel before the Lyceum :

" While on an excursion through part of the counties of Schenectady and Montgomery, some observations were made on the Geology of these counties, in conformity with that duty which the design of our association imposes on every member of the Lyceum.

" The transition class of rocks continues along the valley of the Mohawk nearly as far as the western boundary line of the county of Schenectady.

" The argillaceous slate disappears, by falling beneath the higher strata, about eight miles from the city of Schenectady—corresponding very nearly with the geological map published by Dr. Steel of Saratoga. The rock under which the slate passes has the external appearance of the rubblestone variety of graywacke; but by testing the rock with acids, it appears to consist in part of carbonate of lime. It is here called bastard limestone. In the course of two miles the rock stratum assumes the distinctive characteristics of the blue compact limestone. The traveller has now before him demonstrative proof, that he has entered upon that secondary region, which continues many hundred miles to the west. This stratum, however, is of very limited extent to the north of the valley of the Mohawk.

President, found that it extended to the Little Falls on the Mohawk, more than thirty miles farther west.* Dr. Steel has ascertained that

"The ancient building of Sir William Johnson, which is called Fort Johnson, 32 miles west from Troy, is built of this stratum of compact limestone. And although it has been built about a century, the stones exhibit no marks of disintegration.

"In going from Fort Johnson to the village of Johnstown, a distance of eight miles, we pass obliquely over a belt of transition rocks, running nearly parallel to the Mohawk. About seven miles north of Johnstown village the country is decidedly primitive. Here we fall in with that variety of *gneiss rocks*, which some geologists consider as of the most recent formation. They are made up of many distinct layers of which quartzose particles are in excess and their position is nearly horizontal. These layers of gneiss are probably a continuation of similar rocks which form the basis of the northwestern part of Saratoga county.

"The village of Johnstown rests upon transition strata; probably graywacke upon argillaceous slate; but the rocks are mostly covered with alluvion. At Johnston Hall, however, (which is three fourths of a mile from the village) the slate appears at the bed of a creek. This slate evidently rests against the primitive rocks to the north."

* Those who have read Governor Dewitt Clinton's Discourse before the New-York Literary and Philosophical Society, in which he denominates the rock at the Little Falls granite, may consider Major Dalaby's opinion as at variance with the Governor's. But it should be noticed, that some geologists blend the granite and gneiss strata; on the principle, that there is no good reason for separating them—their constituents being the same, and they frequently alternating with each other. But I cannot

it extends at least eighty miles to the north. I have traversed it in an oblique direction from Johnstown in Montgomery country, to a place on West Canada creek twenty four miles above its mouth ; where I found that it corresponded in all its peculiarities, with the same rock at Hadley's Falls.

From specimens which I have seen, collected in various parts of this range, and from my own examinations, I think, that a description of this singular variety of gneiss, taken at Hadley's Falls, will apply throughout.

Some layers of the gneiss about Hadley's Falls, in Saratoga county, are remarkably well characterized. I found such alternating with other layers of very peculiar character, from below the falls, to a mile up the river ; and then from the banks of the river to the top of Kayaderosseras mountain. Most of the peculiar intervening layers consist chiefly of fine

adopt this nomenclature ; and as I have examined Major Dalaby's specimens, and know them to be of the most recent formation of gneiss, I adopt his name for the rocks at the Little Falls. His specimens embrace calcareous sandstone, like the same rock at Hadley's Falls ; and Gov. Clinton notices the same fact.

grains of quartz, rather loosely aggregated together. A few scales of mica are generally present and rarely a few grains of felspar. These layers hasten rapidly to a state of disintegration, forming a loose sandy soil. Such is the soil of much of the Jerseyfield tract in Montgomery and Herkimer counties. Such a soil is remarkably warm ; but will devour much manure. In this immediate vicinity I discovered no deep alluvion ; though vast quantities of the sandy kind must have been formed in ancient time. It has probably gone down the Hudson and in other directions.

Another of these intermediate layers would be mistaken for graywacke, without an attentive examination. Col. S. Young informed me, that before he had given much attention to geology, he mistook a similar variety at the Little Falls for greenstone trap. I should not be surprised if every young geologist should fall into this error. For it is coloured much like it and presents regular parallelopipeds. The most striking specimens of this last anomalous aggregate form the bed and low banks of the river, half a mile above Hadley's Falls. This some-

times passes into calcareous sandstone, in which the limestone particles are in such proportion, that it may be manufactured into indifferent lime. It often embraces very perfect rhomboidal crystals of carbonate of lime.

The most remarkable, and to me the most paradoxical, of all these intermediate layers, is the puddingstone. A layer commences near the Falls, and extends up stream along the bank of the river half a mile. The constituent pebbles are all as much rounded, as the most perfect water-worn gravel stones. And the layer is overlayed as well as underlayed with well-defined gneiss. I do not mean that such gneiss is immediately in contact with the puddingstone; but layers of it may be found in the bank above and below it. The pebbles constituting the puddingstone are chiefly translucent quartz, such as we find in granite; cemented together by carbonate of lime and quartzose sand.

I have never discovered many disseminated or imbedded minerals in this range. It contains considerable sulphuret of iron of the soft granular variety; whose decomposition, along the banks of the Hudson near Hadley's Falls, forms

considerable sulphate of iron, or copperas water. The most important discovery, made in this range, is the sulphate of barytes at the Little Falls on the Mohawk. Mr. Isaac Briggs, while he was engineer for the great canal, presented large specimens of sulphate of barytes to the Troy Lyceum, which he discovered at that place. It is the lamellar variety; some of a pearly white and some deeply coloured with red oxyd of iron. Whether it was embraced in the well characterized gneiss, or in some of the anomalous layers, I have not been able to ascertain.

The gneiss on each side of the Highland range of granite is of the common, hard, vertical kind; resembling the New-England ranges. As far as I have had an opportunity to examine, it presented nothing peculiarly interesting. But my investigations here have been less minute and particular than at any of the localities described in this Index.

It is worthy of remark, that the rock strata of the Highlands bear a relation to each other, more analogous to similar rocks described by

European geologists, than in any other part of our district. Here the granite is generally the highest, while the gneiss and other primitive rocks incline against its sides. Whereas such a locality can hardly be found in New-England. There the gneiss is generally the highest.*

The gneiss of the Highlands, as well as the granite, embraces magnetic iron ore, containing minute crystals of phosphate of lime. Where this range passes through Pennsylvania, Mr. Conrad found melanite in it. But I found the same mineral in mica-slate in Conway, Mass.

* Dr. Ackerly has published a very ingenious profile view of the west bank of the Hudson, through the Highlands, &c. But he informed me that he had not been minute in settling the limits of particular strata. It is to be hoped he will find time soon to effect this very desirable object.

STRATUM 3.

*HORNBLLENDE ROCK.**

I HAVE adopted this general name for all rock aggregates of which hornblende is a constituent, excepting the superincumbent class. This may be deemed an unauthorized innovation; but I am conscious of no other motive in introducing it, than the want of any established name, which has ever been applied as I find myself compelled now to apply this one. In the first edition I adopted the word sienite. But I find this term has sometimes been applied even to a variety of greenstone trap. Primitive trap is completely embraced in this stratum, which I denominate hornblende rock; but it

* Sometimes called sienite, primitive trap, greenstone porphyry, green porphyry, &c. See Messrs. Danas' Geology of Boston and its vicinity.

does not embrace *all*, which I think ought to be included in it ; and I have adopted a descriptive name, which is sufficiently comprehensive. I will therefore detain the reader no longer with remarks upon the name ; but will give my reason for uniting in one stratum, what has usually been subdivided.*

My reason for uniting in one stratum all rock aggregates, containing a material portion of hornblende, excepting those of the superincumbent class, is a very simple one. It is because nature has united every variety of this kind of rock, known in our district, in the same individual. When rocks are arranged geologically, no regard must be had to resemblance or constituent elements in establishing their order of succession. All those rocks which are labelled, in European collections, primitive trap, sienite, porphyritic sienite, greenstone porphyry, green porphyry, and by various other names, provided they contain hornblende, and are not basalt, amygdaloid or greenstone trap, or masses embraced in them, are found united in the same individual rock in many parts of New-

* M'Clerc repeats the words, Hornblende rocks, several times.

England. The stratum in which they are united generally rests immediately on gneifs; though sometimes it alternates with it. This I denominate hornblende rock. All the porphyry, which I have found in place in New-England, is imbedded in this rock. The principal localities to which I would refer for proof of these assertions are, Framingham, Belchertown, Monson, Worthington and Plainfield, Mass.

In districts of small extent, the different varieties of this rock may well induce very accurate observers to give them different names. As Belchertown is on the great stage road from Albany to Boston, it may accommodate a curious geologist the best to have minute directions for testing my assertions applied to this place.

All the varieties, excepting that which is called primitive trap, will be found in the same stratum by commencing near the meetinghouse and proceeding westerly about two miles. Then, without losing sight of the same stratum, proceed towards a place in the same town nick-named the Dark Corner. On the right

of the road a small rocky eminence will appear, which is the primitive trap variety.

The other localities afford evidence equally striking, more especially that of Plainfield. But in tracing a continuous rock, we must frequently take many and various turns, lest the alluvion and fields of other strata mislead us.

Some European geologists treat this as a subordinate rock. But its great extent and almost uniform presence in its proper place, certainly entitle it to a place in a system designed for our district.*

Ranges east of Spencer.

Though the hornblende rock stratum is manifest on both sides of Worcester and in place, it is very much broken and limited. East of the gneiss rock, which terminates west of Framingham, this stratum is very extensive. It is in fact, with all its varieties, the basis rock almost to the Atlantic. Messrs. Danas have de-

* Dr. Lyman Foot supposes that hornblende rocks may be applied to great advantage in fortifications, on account of their being the toughest of all rocks.

scribed it very minutely as it appears in the vicinity of Boston, and illustrated it with a coloured map. They have subdivided it into common greenstone, greenstone porphyry, green porphyry, and sienite. The reader may include porphyry as a subordinate or imbedded aggregate also, belonging to this stratum. But he should be cautioned against confounding the rock, denominated common greenstone by Messrs. Danas, with greenstone trap of the superincumbent class. Not having corresponded with these gentlemen, I do not precisely understand by what system they were governed in denominating the extensive rock embracing Weston and the towns north and west, common greenstone. But they cannot in my opinion intend a rock resembling the greenstone hills about New-Haven; because they are very different both in texture and geological relations. I take the New-Haven rocks for a standard of reference; because Col. Gibbs and Professor Silliman, both of whom have seen European greenstone hills in place, declare them to be perfect specimens. Whereas the rock so denominated by Messrs. Danas, is, according to my specimens collected there, pre-

cifully the same as that beautiful green variety of hornblende rock, which rests upon gneiss and frequently contains large veins of granite, in Belchertown. However, at the 42d page they seem to refer prehnite to the true greenstone. I have no doubt but these gentlemen had correct views of their subject ; but these remarks appeared necessary to prevent mistakes. This range, like all ranges of this stratum, frequently contains epidote.

Ranges west of Spencer.

The Belchertown range is more than five miles wide, and holds its breadth to a considerable distance north and south. In Monson, about a dozen miles south, the slaty variety, being the primitive trap of Werner, is remarkably well characterized. It is this same range which contains the cobalt mines of Chatham, Con. But it seems to alternate with gneiss at this mine. Arseniate of cobalt is also found in this rock at Monson in small quantities. It contains epidote and actynolite in abundance in Belchertown.

It appears again, in interrupted fields and patches accompanying the gneiss, on the west

side of Connecticut river. In a fragment of this range Dr. D. Hunt found arseniate of cobalt also.

Between the Northampton and Hinsdale granite there are large quantities of this rock. It was long before I could comprehend the real position of this range of hornblende rock. But by frequent examinations, and by comparing its appearance on our section with that of the south bank of Deerfield river, I came to this conclusion. That the high ridge of this rock, which crosses our section west of the village of Worthington and runs northerly through Plainfield and Hawley to Deerfield river, extends laterally under the mica-slate and talcose rock both east and west. That on the eastern side it appears again east of the top of the mica-slate hill, which lies east of Worthington village. That on the western side it appears again on the eastern face of the high gneiss mountain of Peru. The eastern wing, if I may so call it, appears in Conway in the form of the flaty variety. It appears also near Deerfield river. The western wing also appears west of the town of Hawley, beyond the iron mines. Reference

must be had to the drawing of our section to understand its position.

I think the varieties which this rock presents in Plainfield, Hawley and Buckland, exceed all other localities within my knowledge. Here is the most beautiful porphyritic variety, the bright green, the dark chocolate, the flaty, the granular, &c. At Conway I found in it the petrofilicious porphyry, and in Hawley there are abundance of fine crystals of actynolite and of hornblende. In truth, there is more beauty in the structure of the rocks of Hawley and Plainfield, than of any other place I have ever visited.

On the west side of the Hinsdale range, this stratum is very limited. Yet it seems to be extended along without much interruption, in company with the first layer of gneiss. Exactly against the village of Adams, twenty miles north of our section, I did not discover it in place. But a few miles south, where the road crosses the mountain towards Plainfield, it is distinctly manifest in place; though not of great extent. Wherever I have sought for this range, I have not failed to find it in its proper connexion, throughout the state of Connecti-

cut. I once thought I had found it in place beyond the Saddle Mountain range as stated in the first edition of this Index. I can now account to myself for the deception; but it will be uninteresting to the reader. It evidently passes under the granular limestone and quartz, mentioned under the article gneiss, never to rise again in our district.

This stratum is very manifest at the Highlands. But I do not believe it overlays the horizontal gneiss of the Saratoga range. It seems to have a place somewhere beneath it. Perhaps it is interposed between a lower stratum of gneiss and the horizontal variety. It is very abundant in patches and large boulders in the excavated region between the Kayaderosseras Mountain and the granitic ridge. But I did not carefully trace it to its place.

STRATUM 4.

MICA-SLATE.

THIS stratum is very narrow or thin wherever it occurs in our district.* At least I have never found it of great extent, uninterrupted. It is frequently found in patches or fields strewn over a considerable tract of country. Being more subject to disintegration than any of the three preceding strata; whenever it is exposed it soon becomes separated into patches, disclosing the strata beneath. But where it still presents its whole thickness, as in the banks of Deerfield river and at the Highlands, I have always found it very thin.

As it uniformly accompanies the preceding

* Bakewell says, there is no well characterized mica-slate in England.

strata and is rarely of much extent, or in continuous uninterrupted ranges, which are exposed to view, I shall not describe the ranges separately.

I found but very little mica-slate east of Shrewsbury. Its proper place appears from analogy to be in the vicinity of Boston; but Messrs. Danas found none there. I saw a few patches of badly characterized mica-slate between Shrewsbury and Framingham.

There is a little mica-slate in patches near Worcester; and scarcely any more occurs along our section until we arrive at Belchertown. Here it appears capping the hills west of Swift river and throughout the town in loose patches. But no where in place again until we come within a short distance of the east end of Mount Holyoke. Here it crosses the stage road in place. By following this range north and south, we actually see it passing over the hornblende rock stratum; clearly separating it from those higher strata on which the greenstone trap, constituting Mount Holyoke, reposes. I mention this, because some superficial observers have considered them as united.

There is very little mica-slate near Northampton. But it is well-characterized and in place between Northampton and Hinsdale. It manifestly lies upon the hornblende rock nearly throughout the whole extent of what I before denominated the eastern and western wings of the Worthington range. It is still more apparent twenty miles north on the Deerfield river. It accompanies the gneiss every where in Saddle Mountain and the other mountains in this chain. Here is no hornblende rock interposed between the gneiss and mica-slate as in Belchertown and between Northampton and Hinsdale. The hornblende rock being in company with the layer of gneiss, which rests against the granite, it is not repeated here with this second layer of gneiss.

Staurotide and garnets are very common in mica-slate. The best locality is in Litchfield, Con. Professor Silliman found elegant specimens in Bolton. Dr. John Torrey found similar ones on New-York island. I found beautiful specimens in Chatham, Con. Mr. Silliman found crystals of pinite in Haddam. Professor Dewey and myself found elegant acicular crys-

tals of shorl in a wall near Williams College, which evidently originated near where we found it; and he has since found octahedral crystals of oxyd of iron. I found acicular crystals of shorl in this rock in Belchertown, Monson and Litchfield.

There are several large masses of mica-slate in Chesterfield, Mass. which contain great quantities of sappare, and garnets of an enormous size. In the same range, near the line between Conway and Deerfield, Mr. — Hamilton of Conway conducted me to a locality of sappare a few miles east of the village. I found melanite in it near the same village in great abundance.

The mica-slate near Swift river in Belchertown and Greenwich, passes into that variety of which the coarse scythe-whetstones are made. In the Worcester range this variety appears in small quantities between Leicester and Worcester, and in large quantities in Smithfield, R. I. In the range east of Peru, where it passes through Middlefield, an extensive quarry of this variety is said to have been lately discovered. I have

seen a specimen of it, but have not visited the place. Another locality of this variety is near Lenox. By disintegration it forms sand suitable for glass manufactories ; and it has been applied with success. Kirwan denominates this variety *Stellstein*. It seems to be a talco-micaeous rock.

I have not been able to ascertain a single fact respecting the mica-slate, or other strata, accompanying the Saratoga range of gneiss ; though I have made much enquiry. I presume the gneiss extends much farther to the west than the West Canada creek ; beyond which we have not explored. There is, however, a field of mica-slate two miles west of Saratoga Springs and a patch lying immediately on the granite near the south extremity of the range, one mile northerly from the Springs.

STRATUM 5.

TALCOSE ROCK.

IN the first edition I applied the common name soapstone to this stratum. But by the advise of Professor Silliman, I have adopted this name. There is certainly great propriety in substituting this name; as it is intended to comprise all rocks, in which talc is a material constituent. Such as common soapstone, steatite, potstone and that kind of shistose rock which is distinguished from mica-slate merely by a kind of talc glazing. This last variety constitutes a part of Saddle Mountain and that shistose ridge which crosses the stage road between Pittsfield and Dalton.

I saw several patches of this stratum lying upon mica-slate in East Sudbury. It was very

coarse and hard, containing but little talc. It appears in small quantities on both sides of Worcester valley. As low down as Smithfield, R. I. it is considerably extensive, and much used in the arts. There is a north and south range of patches of this rock, in connexion with calcareous sandstone and granular quartz, passing one mile east of Belchertown meeting-house, which I have traced for several miles. It is interrupted thence until we fall in with the mica-slate near Mount Holyoke. It appears in small patches again on the west side of Connecticut river. In connexion with the mica-slate east and west of the Worthington hornblende rock, it is more extensive. In Middlefield it becomes a very extensive quarry of soft soapstone; and Mr. Emmons of that place has traced it to where it passes into beautiful serpentine. This is in the same range as the coarser variety forming the eastern face of Snake Hill, between Worthington and Peru.

Just at the meeting of the mica-slate and the talcose rock,* where they pass into each other,

* Bakewell speaks of this talco-micaceous rock being common in Anglesea. P. 84.

is the proper place for the specular iron ore. Such is the situation of the Hawley mine, which has been wrought 20 or 30 years. The walls are mostly a very white talcose rock, and black micaceous iron ore. The whole mine is included between two vertical rocks about four feet asunder, running north and south. The depth is unknown. This is the same range with Snake Hill and Middlefield quarry.

Adjoining the mica-slate in Saddle Mountain, that variety of talcose rock which contains little more than a mere glazing of talc, is pretty extensive. On ascending to the Grey Lock from the Hopper* we pass over it in the best place, perhaps, for collecting specimens. Sixteen miles south, where this vast mountain has dwindled down to a mere ridge of rock, nothing is left but this stratum. Where it approaches the stage road between Pittsfield and Dalton, it contains the smallest proportion of talc, which can entitle it to the appellation of talcose rock. But from a consideration of its analogies, it must be placed in this stratum.

* See Professor Dewey's excellent essay on the Geology of Williamstown in *Am. Jour. Science*, page 337.

This range is remarkable for its alternations with granular limestone. It extends southerly through Massachusetts, thence through Sheffield, Canaan, Salisbury, &c. Con. It alternates with the limestone three times in the towns of Salisbury and Canaan—the talcose, or talco-micaceous rock forming high hills, and the limestone the intervening valleys. It extends northerly far into Vermont. It forms a high mountain near Middlebury College,* and becomes of great extent still higher north. Here it embraces most beautifully variegated serpentine of the common soft variety.

It may be worthy of remark, that the serpentine, found in talcose rocks in our district, is always softer than that which is found in granite.

It will seem to be taking a bold, or rather visionary, ground, to say that the stalactitic (hematitic) iron ore of Salisbury mine, was once specular iron ore, imbedded in this range of talco-micaceous rock, similar to that of Hawley, Mass. But when the reader is informed.

* Dr. Edwin James.

that the only rocks in the vicinity of the mines are of this kind, very similar to those in which the specular ore of Hawley is imbedded, and that the alluvion embracing the ore in its present state appears, by mere inspection, to have proceeded from the disintegration of a similar rock, it will begin to appear somewhat plausible. In addition to this, these iron stalactites are always pendent when laid bare before they are moved. They must therefore have been in a state of fusion as recently as the time when the alluvion was formed. And these stalactites are always suspended from masses intermixed with the soil in such a manner, that it is evident the iron was in a state of fusion when in contact with it. The foot, which still adheres to all stalactitic specimens, proves, that the heat was continued after the ore was confined in its present state. If it was ever fused down from any rock, it must have been the same out of which the alluvion embracing it was formed. The cause producing such a high heat I shall not attempt to assign. But that the ore exhibits sufficient evidence of its having been recently fused, I believe no one can question, who has ever inspected it in place. I mean by recently, since

all general strata were completed, and during the era of alluvial deposits.*

Talcose rocks are found in place along both sides of the Highland range. It is a principal rock at Hoboken and Staten Island near New-York; and appears to belong to, or incline towards, the granitic ridge of New-York Island. Dr. Bruce found pure magnesia (hydrate of magnesia) in this rock at Hoboken. Mr. Pierce found both hydrate and carbonate of magnesia on Staten Island in the same stratum.

In that variety of serpentine which is often connected with this stratum, Dr. Hayden discovered the chromate of iron near Baltimore, Md.

* Extract from a letter, which I wrote to the corresponding secretary of the Troy Lyceum (Dr. A. Robbins) while I was acting as collecting agent, dated Litchfield, Nov. 17, 1818.

"The Salisbury ore-beds present materials for contemplation of the highest interest. That the ores are strictly stalaclitic cannot be questioned. But whence were the materials derived, and by what agent were those materials brought into the liquid state? By the elegant specimens which I have collected for the Troy Lyceum, it will appear, that the stalactites are now actually covered with black velvety foot, and exhibit many other signs of having been exposed to substances in the state of combustion."

He represents this very interesting locality of chrome as in a bare, bleak, ragged rock, unfit for the residence of any animated being, excepting those of the most hated class. "If," says he, "a fratricidal Cain had here committed his heaven-insulting deed, we need not wonder; it bears so much the appearance of having experienced the unappeased wrath, the eternal curse of an offended Deity. Scarce a solitary lizard, or a creeping ant is here seen, seeking among the mouldering serpentine a peaceful burrow in which to deposit its daily spoils, and screen its tender offspring from the chilling blasts of winter's wind, which sweep in triumph over this dreary waste."

STRATUM 6.

GRANULAR LIMESTONE.*

THIS stratum is very limited every where east of Hinsdale ; but west of that range it is one of the most interesting of all the strata.

Ranges east of Hinsdale.

Messrs. Danas found granular limestone in connexion with argillite near Merrimack river, northwest from Boston. They treat it as a subordinate mineral. But it being in the same connexion as found in thousands of acres near the west bounds of Massachusetts, I should be

* This is called crystalline limestone by Bakewell and others. In the first edition of this Index it was divided into granular limestone and quartz, calcareous and granular quartz, and metalliferous limestone. I am now satisfied that they all belong to the same stratum.

inclined to consider their locality as a remaining patch of this broken down stratum. But as I never saw a fragment of it east of Shrewsbury, I would merely propose this suggestion for the consideration of Bolton geologists.

Fragments of this stratum are found along the Worcester valley. And at Smithfield, 20 miles south, as well as at Bolton, 12 miles north, it is found in quantities sufficient to afford building quick lime for all the neighboring towns.

I have never discovered any granular limestone between the Spencer and Northampton ranges of granite ; but I presume it may be found. It is the highest stratum which occurs between the Northampton and Hinsdale granite ; therefore the whole of this mountainous region is primitive. At Worthington the granular quartz, which always accompanies granular limestone, is abundant. And that variety of granular limestone, which is aggregated with considerable quartz,* is found here in

* Bakewell says, that the granular limestone of Europe often contains a considerable quantity of silicious earth. P. 87.

place ; though not in great quantities. I have traced this range to Deerfield river, about twenty miles north. Towards the west bounds of Hawley the proportion of carbonate of lime increases, and the stratum extends in breadth. But still it contains a large proportion of quartz.

In its whole extent it rests immediately upon the talcose rock. And, though it is different from the granular limestone west of Hinsdale, it precisely resembles the latter in many localities, where it approaches the strata above and below it. Therefore, since it is in the same geological connection as the upper, or most western, division of the Pittsfield granular limestone, it appears most convenient to consider them as analogous strata. To support this analogy, we may consider this Worthington range as resembling the western side of the Pittsfield stratum ; but that it is not extended sufficiently to present the pure limestone of the middle part of Pittsfield range.

There is a range of a similar stratum reposing on the talcose range east of the Worthington and Plainfield high ridge of hornblende rock ;

but it is not of much extent on our section. As far north as Conway, or even the north-west part of Williamsburg, it is considerably extensive. It has here been manufactured into indifferent quicklime.

From a consideration of these localities, I was induced to locate *all* granular limestone next above the talcose rock ; which is the actual situation of the Pittsfield range. Though the alternations and subdivisions of the western granular limestone, which passes through Dalton and Pittsfield, afford but little conclusive evidence of its true place in a system of geology, this arrangement comports better than any other with all phenomena relating to it and its connexions.

Ranges west of Hinsdale.

Limestone of this kind is considered by Bakewell and some other European geologists as a subordinate rock. But a vast stratum, extending from near Long Island to Canada, ought certainly to have a place among regular strata. Besides I have no doubt analogous rocks may be found in place, in every part of New-Eng-

land ; though they are less pure carbonate of lime, and of less extent.

I have traced this range from Reading in Connecticut through Bethel parish in Danbury, Brookfield, Washington, Cornwall and Canaan. Here it alternates three times with mountains of talco-micaceous rocks on the cross road to Salisbury mines. And the main range running northerly, divides into two distinct branches, which continue separate across Massachusetts and far into Vermont. The east branch passes through Tyringham, Mass. Washington, Dalton, Adams, &c. The west branch passes through Great-Barrington, Stockbridge, Richmond, Pittsfield, Lanesborough, Williamstown, Pownal, Vt. Bennington, &c. It has been traced almost to Canada, by several correct observers. I have myself traced it into every town here named. When I was engaged in searching out the course of this remarkable stratum at the direction and expense of the Troy Lyceum, I was very anxious to follow the course of the western valleys beyond Salisbury, before described ; but I should have exceeded my instructions. Whether they lead away westerly to Hudson river at the Barnagat

lime-kilns, sending off a branch to New-York Island, or return soon near the course of the principal range, I have not been able to determine. Dr. Akerly found granular limestone both in Dutchess and Westchester counties, very nearly in line between Salisbury and Barnagat, and between Washington and Kingsbridge.

All the branches of this stratum are accompanied by granular quartz rocks, mostly of a yellowish hue. Near Williams College, the granular quartz forms the chief part of several mountains. There are two within three or four miles of the College, from twelve to fourteen hundred feet high.*

From the preceding enumeration of facts it appears, that this stratum alternates with all the primitive strata, excepting granite and the hornblende rock. And I think I have some evidence of its alternating with the latter also.

Near the east line of Danbury, Conn. in the parish of Bethel, a creek cuts across a ridge

* See Dewey's Geology of Williamstown.

with perpendicular banks, about forty feet high. Here the granular limestone and gneiss alternate with each other several times in succession within a very short distance. The limestone is perfectly white and extremely coarse-grained. Here the layers dip to the west; but in West Stockbridge and Alford they generally dip to the east, though there seems to be no uniformity in their direction. Had some force, applied at the eastern edge, raised these mountain masses from the horizontal towards the vertical position, leaving some inclining to the east and forcing others beyond a vertical position, they would have presented their present inclinations.

This stratum is found in Pennsylvania and Maryland, (Conrad and Gilmor;) but I have received no information respecting its geological situation. The Milford marble is of this stratum; but to what range it belongs, or whether it is insulated and independent, I am not able to determine; though I examined its geological situation with that view. It appears to be, *geographically*, in the course of the range crossing our section at Worthington; but it resembles the Pittsfield range.

There is frequently considerable proportion of carbonate of magnesia combined with the carbonate of lime, forming Dolomite throughout all the extent of this range from Pittsfield, Mass.* to Reading, Con. Tremolite is frequently found in it; and in Canaan, Con. it is very abundant. In Brookfield, Con. I discovered a new locality of pyroxene, or white augite, in this rock. It is very abundant about half a mile west of Brookfield village. Sometimes it contains asbestos, serpentine,† iron, pyrites, &c. Dr. Meade discovered that flabs of this rock, when wrought out pretty thin, are often elastic.

In Alford, and several other places, it contains mica and talc. Here, (Alford,) I found it frequently passing into precisely the same variety as that mentioned in Hawley, belonging to the Worthington range.

* Since writing the above I received a letter from Professor Dewey, dated April 7, 1820, in which he informs me, that he has found Dolomite in abundance in this range north of Williams College, near the south bounds of Vermont.

† It contains serpentine, forming verde-antique, also in Scotland.—*Bakerwell*.

The most durable marble is manufactured from this stratum, throughout most of its extent. This is the genuine statuary marble. There is no doubt, but it may be quarried in almost every part of the range; though the appellation, Stockbridge marble, is given to the whole. The New-York City Hall is built of this rock. In some parts it abounds in iron pyrites, which is injurious to the marble. But it is generally a pure white, or a little mottled with light blue; and free from all metallic ores.

West of Pittsfield, near the eastern boundary line of the state of New-York, it passes under the vast stratum of argillite. Fortunately here is no room for conjecture. By mere inspection we actually see the granular limestone pass under the argillite for at least twenty miles in extent from north to south. Along the stage road west of Pittsfield, the limestone is united with a considerable proportion of quartzose particles or sand; so that it resembles the variety which generally prevails to the east of Hinsdale. It is often blackened on its surface by the decomposition of sulphuret of iron, near the argillite.

II. TRANSITION CLASS.

STRATUM 7.

ARGILLITE.

THIS stratum is rather limited wherever it appears in New-England. But in the state of New-York it forms the basis rock of more than two thousand square miles.

In Professor Silliman's notice of the first edition of this Index, he says; that the clay-slate of Woodbridge hills near New-Haven, is primitive, that of Rhode-Island with anthracite is transition, and that near Middletown, Con. with impressions of fish is secondary. There

fore he infers that, by confining argillite to the transition class the science may be embarrassed.* Such a suggestion made by one of my principal instructors in Mineralogy and Geology, would naturally induce me to search dilligently and decide with caution. Having found myself compelled, by a review of facts, to yield my opinion to his, respecting the supposed range of metalliferous limestone in Massachusetts ; I was prepared to yield also in the case of the argillite. But after the most diligent search and reviews, I think I have the best of reasons for leaving the stratum of argillite exclusively in the transition class.

All the primitive, which has come to my knowledge, was manifestly in beds in granite, gneiss or mica-slate. And even these beds are very limited. The President of the Troy Lyceum, the Hon. John D. Dickinson, Esq. brought home very perfect specimens from near Lake Champlain, which he found imbedded in granite. The bed was of very little extent. Dr. Edwin James found similar beds in several localities in Vermont. In truth I have not

* See American Journal of Science, page 70.

been able to ascertain a locality of the primitive slate, which was not manifestly a bed, or a subordinate rock.

With respect to the secondary argillite, this has always been found in very limited beds in our district. That which contains the fibrous sulphate of barytes in Schoharie county is certainly a mere bed, and very different in texture from either primitive or transition argillite. It may rather be denominated argillaceous graywacke than argillite.

Perhaps the question may be asked, how shall we determine whether it is a bed or a stratum? The same question may be asked respecting serpentine, dolomite, &c. I treat every rock as subordinate, which is wholly embraced in other rocks when in place; and which never appears independent and continuous in large districts. Bakewell says, p. 98: "If all the varieties of rock found among the primary* were arranged in distinct orders, the number would be indefinitely extended,

* I think this remark applies with equal force to the transition, and in some measure to the secondary.

“ and the science encumbered with a list of
 “ names which would be of little use.—
 “ It is, I conceive, better to class these varieties
 “ under one head as *Anomalous*, and to de-
 “ scribe their peculiarities whenever they oc-
 “ cur.”

Now this same variety of argillite, which I consider as transition, is the basis rock throughout several counties in the state of New-York. It appears in several limited ranges in New-England, and always in the same geological connexion, when clearly ascertained in place.

The next question is, why should it be placed in the transition class,* if it be admitted, that there is but one kind of sufficient extent to form a stratum, and that it is always found in the same geological connexions? The answer is a,

* Bakewell observes, p. 101 : “ Geologists have been frequently perplexed in attempting to determine whether certain rocks belonged to the transition class. The uncertainty arose principally from placing argillaceous schistus in the class of primary rocks.” At page 102, he adds : “ That slate which lies nearest the primary rocks has a more shining lustre than the other, and partakes more of the crystalline quality of mica-slate. As this recedes from the primary, it more frequently contains organic impressions.”

simple one. It is the lowest rock in our district containing organic relics, these are always of marine origin ; and it rests immediately upon granular limestone, which is the highest primitive stratum.

Organic relics are extremely rare in this stratum ; but it is so remarkably continuous and uniform, that a single specimen in it, if well ascertained, is sufficient proof. Dr. Edwin James found several *anomites* and *pectinites* in the very same stratum which passes under this city, (Troy,) where it approaches Lake Champlain. The very perfect specimen of *orthocerite*, which was dug out of the rock at the north end of this city is conclusive. This fact is perfectly guarded against the possibility of mistake. It was inspected in place by Dr. Wells, Dr. Hale, and several other members of the Lyceum. I have frequently seen the rock from which it was taken. It was discovered while cutting a street through a solid rock of argillite about four feet below its surface. This same rock may be traced unbroken throughout more than two thousand square miles. It embraces a large proportion of the counties of Saratoga, Sche-

nectady, Albany, Rensselaer and Columbia. It extends into the west margin of Massachusetts, and there rests immediately on the granular limestone.

Ranges east of Hinsdale.

When I was engaged in searching into the geology of the vicinity of Boston, I was induced to believe that this stratum existed under the deep alluvion, principally from the large patches and fragments which I found there. For when a stratum of a soft rock is not near, we never find even boulders or patches of it. We find large blocks of granite, gneiss and hornblende rock in the vicinity of Troy, thirty or forty miles out of place. But we never find mica-slate or talcose rock. I have observed the same fact in Blenheim, Delhi, and other towns in Delaware and Schoharie counties. Hence when I find large fragments of a soft rock, I infer that it is not far out of place. Besides, the graywacke commonly accompanies argillite, and overlays it. Therefore I had good reason to receive the presence of graywacke, as evidence of the proximity of a stratum of argillite.

Messrs. Danas have confirmed this opinion by an extensive course of observations.*

A little west of the village of Worcester this stratum appears of considerable breadth. And it increases in breadth both to the north and south. Pretty large quarries are now wrought in Smithfield, R. I. to the south, and in Bolton to the north.

The Connecticut river range is considerably extensive in Vermont; but as it runs southerly it descends beneath the other strata, and entirely disappears in Greenfield. It probably passes beneath the graywacke, as this becomes a pretty extensive rock a few miles south of Northampton.

Mr. Hitchcock calls the Connecticut river argillite, primitive. In this he is governed by European descriptions of hand specimens. But specimens answering to their definitions of roof, and primitive, slate, may be found here, and every where else in our district, within a few feet of each other in the same individual rock.

* See the Geology of Boston and its vicinity, page 108.

The primitive argillite brought to the 'Troy Lyceum by Mr. Dickinson from the west part of Vermont, is totally different from any I have seen from Connecticut river, from Boston or from any part of the vast range in the state of New-York; though specimens may be selected, which accord with the letter of the definition. Since the argillite on Connecticut river,* at Worcester and Boston, is in the same geological position as that in which organic relics are found, and does not essentially differ from it in structure, I have thought proper to consider them as analagous strata.

We now pass over the interval between Northampton and Hinsdale, as it is wholly primitive.

Range west of Hinsdale.

I cannot fix the northern or southern limits of this range. It has been traced from Vermont

* I have been informed by an intelligent young gentleman, who has resided twenty years near Bellows Falls, Vt. that much of the argillite in that vicinity presents highly inclined laminae, and in all respects resembles that variety of argillite in Rensselaer county, which contains organic relics; though he never saw any relics in it on Connecticut river.

through the counties of Washington, Rensselaer and Columbia into Dutchess. Near Poughkeepsie it winds westerly, crossing the Hudson into Ulster county. From the southern part of Columbia county to about as far north as Albany, a distance of about 50 miles, it is chiefly embraced between Hudson's river and the Massachusetts line—a breadth of about 20 miles. Some distance below Albany, near Kinderhook landing, it extends across the river, and spreads out gradually to the west as it advances northerly ; so that it embraces a large portion of that part of the counties of Schenectady and Saratoga which is situated nearest to the river.

It is remarkable, that in almost every part of this range the laminae are nearly vertical, or inclining a little towards the west or northwest. Not having been able hitherto to adopt any tenable theory respecting this phenomenon, I will give Bakewell's. He says, page 103, “ This rock is always represented as stratified ; “ but in this respect it resembles gneiss and mica-slate, and the flaty and tabular structure “ are, I conceive, the effect of crystallization, “ depending on the nature of the constituent

“ parts. In the slate rock at Charnwood Fo-
“ rest the flaty laminae make an angle of sixty
“ degrees with the principal seam by which
“ the rock is divided.” Whether this is the
true cause of this arrangement of the laminae
or not, it is interesting to know, that a similar
structure has been observed beyond the Atlan-
tic. The dividing seams forming a large angle
with the laminae are manifest in many locali-
ties; particularly along the banks of the Mo-
hawk near the Cohoes Falls.

In some parts of this range the laminae are
curved, at others strait, in others irregularly fis-
sile and readily shivered into lenticular or formless
fragments. Where the laminae are strait, this
stratum is quarried and manufactured into roof
slate. One quarry has long been wrought near
the north bounds of Dutchess county and one
in Rensselaer. There is another locality not
wrought where nature has opened the quarry, on
the bank of Stony Brook in Chatham, Col.
eounty, on the land of Major Eleazer Cady.

The curved or undulating kind may be found
in various parts of the range. It is very abun-
dant towards the east bounds of the town of

Chatham. The irregularly fissile variety abounds near Troy and Albany. In the cleavages of this variety the fragments are frequently glossed over with carburet of iron. This glazing or gloss is very common near Cohoes bridge, at the Canal between Troy and Lansingburgh, at Greenbush and a little south of Albany.*

Near Massachusetts line west of West Stockbridge, the argillite passes into chlorite slate. Here too the veins of milky and greasy quartz embrace large masses of pure chlorite. This variety of slate, as well as the veins of quartz containing chlorite, are found in almost every part of the whole range; but more particularly near its eastern edge. Adjoining the chlorite slate it is often curiously variegated in colour. We find it deep red, brick-colour, purple, bluish purple, and deep blue. All these colours

* This is the variety, which has deceived so many European colliers, as well as scientific geologists. The appearance very nearly resembles bituminous shale, which accompanies coal. This has induced much fruitless search for it. Several hundred dollars have been expended in digging into this rock. It remained for the members of the Troy Lyceum to detect the deception; and at their request Professor Silliman analyzed this glossing, and found it to be very hard carburet of iron.

may be found in travelling along the turnpike road from West Stockbridge meetinghouse towards Hudson, within four miles of the state line. The best locality is along the descent of the hill, east of the place nick-named Pilfer-shire.

Two or three miles west of Williams College, where this range passes along northerly, I found large quantities of graphic slate or drawing slate, in connexion with both chlorite, and talcose argillite.

Sinople jasper is found in various parts of the range. I have seen it in Columbia, Rensselaer, Albany, Schenectady, and Saratoga, counties. A student at Williams College found one specimen of beautiful striped jasper. Several specimens have also been found in the vicinity of Troy; and one large specimen of the most beautiful grass-green.

Cubic masses of iron pyrites are common in every part of the range; sometimes an inch in diameter. Copper pyrites is found in the varnished variety, at the canal between Troy and Lansingburgh. A singular variety of fibrous

or striated quartz is very abundant in the seams of the varnished variety of argillite in the vicinity of Troy. Below where Buel's graywacke quarry rests on this rock, in the banks of Wy-nant's Kill, this variety of quartz may be found in veins many feet in breadth, from one to two inches in thickness, and ten or twelve inches in length—calculating the length in the direction of the striae. I carried specimens to New-Haven, and on comparing it found no such variety in the great cabinet of Gibbs.

At New-Lebanon Springs and in Pownal, Vt. near the house of Mr. Hall, the argillite passes into alum-slate. The exposed parts, at the last locality, become perfect alum, or at least there is no sensible difference between the alum of commerce and that manufactured in this workshop of nature.

Several springs highly charged with sulphuretted hydrogen issue from the varnished variety of argillite near Troy and Albany. Griscom analyzed one spring near the mansion of George Tibbits, Esq. in Troy and pronounced it a genuine hepatic spring. There is one spring in Greenbush, opposite to Albany, and another a

little below the city of Albany, so strongly charged with sulphuretted hydrogen, that a piece of silver coin becomes tarnished in a few seconds after being dipped in it.

Most geologists, as Phillips, Jameson and others, follow Werner in making a distinct stratum of silicious slate or transition flinty slate. But I follow Bakewell in considering the argillaceous, and silicious slate as passing into each other. He says, the flinty slate "appears to differ from common slate by containing a greater proportion of silicious earth." I have good authority for doing this, within half a mile of the Troy Lyceum. For the shore between the upper and lower Ferries opposite to Troy, is a naked rock of distinctly characterized argillite and silicious slate, passing into each other several times in succession. Last Spring (1819) I conducted Professor Mitchell and Dr. Akerly to this locality. Both of these distinguished geologists considered it as conclusive evidence, that the flinty slate ought not to be geologically separated from the argillite. Phillips says, p. 134, the "flinty slate is of small importance; it principally occurs

“ in Bohemia, and in the lead hills in Scotland.” And I do not remember that the indefatigable Bakewell gives any new locality. Perhaps it is more extensive in our district, than in any other hitherto explored. I have found it towards the western part of our range of argillite all the way from Schenectady county to Dutchess. The city of Hudson is mostly built upon alluvion, which evidently rests upon flinty slate. The hill or bluff adjoining the river Hudson, is a naked rock of this kind. The basis of Mount Marino, south of South Bay, is flinty slate; though it is capped with graywacke. Near the south end of the Causeway is a remarkable locality of Lydian stone, or Bafanite, in the same rock. Specimens of it are also found in the vicinity of Troy.

There is a vast rock half a mile east of Lansingburgh called Diamond Rock. All its fissures or cleavages are lined with crystals of quartz; and most of its surface is sprinkled over with them. It consists of coarse grains of quartz aggregated together; but totally unlike true granular quartz. For the grains of the granular quartz have but little lustre, and are

mostly opaque and of a dull white or of a yellowish hue. Whereas the grains of this mass are translucent, and have a glassy lustre so as to present a considerable degree of brilliancy. As soon as geology had awakened a spirit of enquiry in this vicinity, this rock became a subject of considerable speculation. But it was ere long discovered, that loose masses of a similar rock were spread over every part of this slate-rock district. Though none were found so large as Diamond Rock ; they were very common of many tons weight, and thence down to the most minute pebbles. Whence were derived such quantities of a similar rock, spread over two thousand square miles of territory ? Was there ever such a stratum overlaying the argillite ? These enquiries were repeatedly made ; but no solution was attempted. A few other aggregated masses were observed by my pupils in this part of our district, which I could refer to no assignable place in the systems of geology ; and they all seemed too extensive to treat as accidental aggregates. But as soon as the thought occurred, that the vast extent of naked argillite in the neighborhood of the Cohoes Falls on the Mohawk, might present something

tending to obviate the difficulty, all speculation ceased. If the lofty banks of the Mohawk are examined from the Falls down towards the Hudson a few miles, the same aggregate will occur in scores, embraced between the laminae of argillite. It requires no train of deduction to prove, that, when the soft argillite passes away by disintegration, those silicious masses will endure and remain in the alluvion.

I found, in the same situation, all the anomalous aggregates, common to this flaty territory. Blocks of calcareous sandstone, specimens resembling metalliferous limestone, calcareous spar, and various other stones, are here embraced; but never pass into the argillite nor present any characters indicating any relation to it.

I have dwelt so long upon this subject, because these facts may tend to elucidate analogous phenomena in regard to other strata, as well as those which relate to this vast range of argillite.

Argillite contains veins of milky quartz in England, according to Bakewell;* and near

* Page 240 and 241.

Washitaw Hot Springs, according to Schoolcraft.* I have already noticed the same fact in our district. I may add, that those large masses, which so frequently occur in the counties of Columbia, Rensselaer, Saratoga, &c. were evidently left by the argillite, after it had become disintegrated. There is a remarkable mass more than one hundred feet in diameter, in the town of Chatham, Columbia county, on the east side of Indian Brook, near Starkweather's tannery. It consists of amorphous milky quartz, with hexahedral crystals disseminated throughout the whole mass. I have broken off crystals three inches in diameter. But the larger crystals are not so transparent as the smaller. Both terminal pyramids are very perfect on quartz crystals in argillite near Albany and Troy. Mr. William Yates presented one to the Troy Lyceum, six inches long and three inches in diameter, with both terminal pyramids, which he found near Troy. Dr. Low found the most perfect, large, limpid crystal I ever saw, in argillite at Greenbush.

* Page 183.

STRATUM 8.

*METALLIFEROUS LIME-
STONE.*

AFTER it had been demonstrated, that the western division of the granular limestone, passing through Pittsfield, was not the metalliferous stratum, as it united with the eastern or Dalton division in Canaan, Con. it seemed to be admitted that there was no such stratum in our district. But as soon as Dr. Edwin James, a member of the Troy Lyceum, had taken his geological excursion from Albany to Canada, a different opinion began to obtain among geologists. He discovered a stratum of carbonate of lime, which he traced from near Ticonderoga to Burlington, below the red sandstone and above the argillite. And as he discovered no graywacke beneath it or east of it, and saw some evidence of its existence as a stratum immedi-

ately above it ; he concluded that this lime stratum was between the graywacke and argillite.* At any rate, he ascertained the fact of its being interposed between red sandstone and argillite ; and that it was too extensive and independent for an imbedded mass. In addition to this, he found it contained organic relics ; of course it could not be the primitive stratum.† From

* This is its position in Brocken Mountain, Germany.—Phillips, p. 114.

† Extract from a paper read before the Troy Lyceum, by Dr. Edwin James.

“ The bed and both shores of Lake Champlain, St. John's river, and the island of Montreal are transition and secondary.

“ At Ticonderoga the rock is granite, with gneiss and sienite inclining against its eastern and western sides. The compact limestone, forming the basis rock of Montreal island, the shores and islands of St. John's and Champlain, abounds in organic relics and masses of hornstone. Frequently it consists in part of silicious sand. The largest proportion of the organic remains is made up of *anomites*. *Pectinites* are next in quantity ; *orthocerites* and *ammonites* are not uncommon. *Corallinites* (by some considered as a species of sea-weed) are occasionally found here. At Crown Point the relics are not so abundant. Here the limestone has been cut through in constructing the fort, and it is found to rest on breccia. Beneath the breccia is the red sandstone, which here contains relics probably of *corallinites* ; though in one instance I discovered univalve *moluscae*. Sometimes this stratum passes into a kind of variegated sandstone, or something resem-

the specimens which he presented to the Troy Lyceum, it is manifest that it does not

bling granular quartz. All these rocks hold nearly a horizontal position.

"A range of hills runs along the east side of the lake from about five miles east of Ticonderoga through Burlington, &c. which consists of red sandstone, passing into a light coloured sandstone upwards. It frequently rises to the height of one thousand feet above the surface of the lake. Beneath the stratum of red sandstone, and perhaps below where the sandstone passes into graywacke, is a stratum of limestone resting on argillaceous slate. I am inclined to consider this stratum as the true *transition* or *metalliferous* limestone, notwithstanding its existence in North America has been questioned. Its texture is intermediate between the granular and the compact strata. Being below the sandstone it cannot be the compact or secondary stratum; and as it certainly contains organic relics, it cannot be the granular. I venture, therefore, to consider it as the same stratum with that in which the silver mines of South America are imbedded.

"The argillaceous slate, upon which the transition limestone rests, contains argillaceous iron ore, calcareous spar, sulphuret of iron, and, in one instance, I found *corallinites* embraced in it.

"In the vicinity of Middlebury College, I have not been able to trace the arrangement of the strata with much satisfaction to myself; though I examined them more attentively here than at any other place. The country is decidedly primitive, consisting of granular quartz, granular limestone, mica-slate, talcose rocks, &c. In addition to the common difficulties attending geological researches made in primitive countries, here seems to be a kind of interference among several cross ranges. The Green Mountain range ought to be attentively and minutely examined by an experienced geologist, who has leisure to compare the various appearances on an enlarged view of the whole chain."

belong to the compact or secondary limestone. It appears to be intermediate between granular and compact, or rather approaching the granular, in its character or texture. We will anticipate so far as to inform the reader, that the compact limestone is always above (never below) the red sandstone, where both are present, in our district.

G. R. Davis, Esq. a member of the Troy Lyceum, has discovered a pretty extensive stratum of limestone in Hoofack, Rensselaer county, interposed between the graywacke and argillite. Its texture is also intermediate between the primitive and secondary. It is precisely in the true geological and geographical locality to be a continuation of the stratum observed by Dr. James. I have frequently observed a range of limestone passing through New-Lebanon, Canaan, &c. in Columbia county, of a texture much more compact than the granular stratum. But I considered it as a continuation of the Pittsfield range of primitive; passing under the hill of argillite west of Pittsfield, and appearing again at this place. I may, however, have been biased by theory so far, as to be convinced

without sufficient examination.* Perhaps this range may appear to be a continuation of that which has been observed by Dr. James and Mr. Davis; as it is precisely where it should be, if it is extended in a manner analogous to other strata. It is hoped that some of the members of the Hudson Association of Naturalists, will extend their zeal to the investigation of this subject. For the present I shall consider it as alternating with argillite in this place. Dr. Akerly discovered the ores of lead, copper and zinc in limestone in the town of Amenia in Dutchess county. It is very probable this is the true metalliferous limestone. It would be doing the science a favor, if some geologist near that locality would trace it so far as to discover its geological relations.

The great silver mines of Potosi in South America are in this stratum. We have a spe-

* Bakewell says, p. 135, "It is always desirable, but perhaps
"not always easy, to keep the description of facts distinct
"from the language of theory. With this limitation theo-
"ries have their use, not only as they assist the memory in con-
"necting insulated facts, but also as they induce us to examine
"nature, in order to prove the truth or fallacy of the system
"which we may be inclined to form or" controvert.

simen of it in the Troy Lyceum. Wherever limestone is found containing ores, if it is not compact, we may suspect it to belong to this stratum. I have never found any ore, excepting iron pyrites, in granular limestone.

This stratum seems never to have been sought by geologists in New-England. Excepting in the Connecticut river range, which passes down to New-Haven, and some limited patches in the vicinity of Boston, there exist no rocks which, from analogy, should be expected to accompany metalliferous limestone in our section.

Mr. Schoolcraft found metalliferous limestone in Missouri;* but he did not particularly ascertain its geological connexions. I. M'Conihe, Esq. found limestone, which appears to be of that stratum in several of the western states. M'Clure mentions beds of this rock running through Pennsylvania, &c. of a blue, grey, red and white colour, in company with graywacke slate.†

* See Schoolcraft's View of Missouri mines, p. 195.

† See his Observations on the Geology of the U. States, p. 41.

STRATUM 9.

GRAYWACKE.*



NEXT to the compact limestone the graywacke is the most extensive stratum in North America. According to M'Clure it appears, that it commences in the Mississippi Territory and continues unbroken to Lake Champlain at least, and perhaps into Canada. It forms some of the principal ranges of the Allegany, and all the Catskill, mountains. In our own district it forms the basis rock of more than ten thousand square miles.

Ranges east of Hinsdale.

I found several patches of well characterized graywacke slate along the valley of Worcester.

* Sometimes erroneously spelt greywacke, as though it were a compound of the English word grey.

The largest which I saw was near the stage road east of the village.

Messrs. Danas found the rubblestone variety of graywacke in considerable quantities near Boston, as appears by their description. But they say no stratification of graywacke has been observed there. I certainly saw pretty large loose masses lying about Bunker's hill, when I was there, of the finest flaty variety. I have a specimen of it now before me. I saw none in place; but from those fragments I suspected its place might be found in that vicinity.

There is a pretty extensive locality of graywacke slate south of Northampton, alternating with red sandstone. It is a very common stone in the side-walks at Northampton. I have seen it where it constitutes a small hill, at the outlet of Salstonstall's pond at East-Haven. Also in a pretty extensive field between the Milford marble quarry and the village of Milford. It is greenish and might be taken for greenstone trap by an inexperienced observer. I do not know what range to class it with, as I before said of the Milford marble. It is however a

very limited stratum in New-England. So are all transition and secondary rocks, excepting red sandstone.

Range west of Hinsdale.

I will now return to the proper region of graywacke. It reclines immediately on the argillite along the whole length of the west bounds of Massachusetts. But it is either cut off together with the argillite by the valley of New-Lebanon, or both strata alternate with the metalliferous limestone. In the transverse section I have adopted the latter opinion; leaving any necessary alterations to future enquiry. Though the graywacke is scarcely interrupted for so great an extent along the line of Massachusetts, it is interrupted by frequent valleys throughout the counties of Columbia and Rensselaer. In truth it merely caps the hills of argillite, excepting in a very few localities, until it passes more than half across the county of Columbia, and entirely across the county of Rensselaer.

A little west of Massachusetts line, directly upon the turnpike road leading from West-

Stockbridge meetinghouse to Hudson, is a locality demonstrating the graywacke (rubblestone) and graywacke slate to be the same rock. Here the graywacke slate is as perfect as in any part of the Catskill Mountain, passing into the coarsest and most perfect rubblestone; all in the same individual rock. This rock is of several miles extent north and south, and the rubblestone is the upper part of it throughout. These two varieties are similarly situated towards the top of Catskill Mountain.

The rubblestone variety is the hardest and most durable. In every part of the counties of Columbia, Rensselaer and Greene, rounded masses of rubblestone, from a foot in diameter down to an inch, are strewed over the fields and along the highways, to the great annoyance of the agriculturalist and traveller.

The graywacke becomes the principal basis rock near Hudson river; though its commencement is in a zigzag line. Near the west line of Chatham on the Hartford and Albany turnpike, in Claverack on the Union Turnpike, and near Albany, there are extensive localities of that brittle variety of graywacke, which Dr.

Mitchill calls brittle slate.* The locality in Claverack meets a field of the compact limestone in a very abrupt manner. Soon after crossing the river Hudson we enter upon the vast territory of perfect graywacke.† Though

* See Bruce's Journal, p. 1.

† Extract from a paper read before the Troy Lyceum, by Dr. I. M. Wells.

"That part of the county of Albany, which is situated near the Hudson, between the city of Albany and Bethlehem, presents very little to interest the geologist; excepting the part which immediately adjoins the bank of the river: being mostly so deeply buried in the proper alluvion, it is difficult to ascertain the basis rock.

"From Bethlehem, twelve miles southwesterly from Albany, nearly to Durham in Greene county, the lowest rocks in view are graywacke; while most of the hills and high ridges are terminated upwards by compact limestone. This upper stratum seems to consist wholly of organic relics, cemented together by the same in a further state of disintegration. The same species of organic remains prevail throughout this district, which are found most abundant in this stratum in every part of the state. *Anomites* and *pectinites* probably constitute nine tenths of the whole. *Terebratulites* and *gryphites* (two of the varieties of *anomites*) are very abundant. A cornute variety of *madreporite*, *encrinites*, *entrochites*, *celleporites*, *retceporites*, *orthocerites*, and *cornuammonites* are often found.

"There are several vast spurs extending westerly from the Catskill Mountains, between Durham Peak and the south bounds of Ulster and Sullivan counties. There is a remarkable uniformity

other strata rest upon it, we discover nothing beneath it in a westerly direction in the state of New-York; and probably not much east of the Rocky Mountain at the head of the Missouri. It forms the valleys and the bases of all the mountains and hills, for one hundred and thirty miles in a westerly direction. About thirty-five miles beyond the Susquehanna river, we

in all these spurs, so far as respects their geological structure. The foundation is always graywacke, and the higher strata are red sandstone and breccia. In some places there appears to be the remaining vestiges of compact limestone.

“ Large boulders of primitive rocks are frequently found here; though not a primitive rock exists *in place* nearer than the Highlands. They are chiefly gneiss and sienite, sometimes granular quartz, and rarely granite.

“ Petrifications abound in all the great spurs of the Catskill, both in the graywacke and red sandstone. I procured specimens of *pectinites*, *gryphites*, and *terebratulites*, near Batavia kill. The inhabitants report that they procure petrified butterflies on the top of a very high mountain, about ten miles from this place. These are probably *trilobites*; because this species of relics is usually called the butterfly, or miller, by the common people.

“ The soil upon and between these mountain spurs is just as a theoretical geologist would conjecture. The graywacke furnishes the silicious and argillaceous materials. Where it approaches the soft argillaceous variety, the soil it furnishes is of course the clayey kind. Where the rock passes into the quartzose variety, it gives a sandy soil. In many places the debris of the lately disintegrated lime stratum is very manifest.”

fall in with considerable compact limestone, under which the graywacke and the red sandstone begin partially to disappear.

A description of the east face of Catskill Mountain, will be a pretty correct description of the whole of this graywacke region. Beginning at the village of Catskill, we meet with a hill of compact bluish graywacke near Benton's bridge, which a careless observer might mistake for greenstone trap. Proceeding along upon the little Delaware turnpike to the Catskill mountain, we find the graywacke uninterrupted; though it is covered with a field of compact limestone for about two miles. On ascending the mountain we pass over all the varieties of this stratum. The east face of the mountain is made up of the perpendicular terminations of horizontal layers, arranged like a flight of steps. This arrangement has induced many of those geologists, who prefer reading in a closet to an examination of the productions of nature, to denominate this the trap formation. This is however an excellent name for a superficial geologist; for it is so vague in its application, that it may be made to mean almost any rock.

Some of the layers are hard, coarse and rough; others are so very soft that during several years residence here, I mistook them for argillite. After ascending about eight hundred feet, we fall in with a layer of red sandstone. From this place the graywacke and red sandstone alternate with each other four or five times in about one thousand feet. There are two lakes on the mountain, which are situated in a depression in it, through which the turnpike road was wrought. On ascending about one hundred feet either to the north or south, the red sandstone, supporting the breccia, becomes general.

I traversed the western spurs of this mountain, taking a survey with chain and compass for about sixty miles westerly, taking three separate nearly parallel routes, about twelve miles asunder. I found the same alternations of red sandstone among the upper layers of graywacke, every where. The rubblestone variety occurred frequently; but was not universal.

If nature would present all her rocks so naked to our view as the graywacke, &c. of this

portion of our district, we should no longer have occasion for nice enquiry. The wild waters of the mad Schoharie, have laid bare a deep winding channel in this range for fifty miles. The Delaware and the Susquehanna have also washed the flat surfaces and perpendicular edges of the same rocks more than one hundred miles.

The fine-grit and the coarse-grit grindstones, precisely the same varieties as those which are imported from Nova Scotia, are found in vast quantities imbedded in this rock, both in Catskill and Blenheim.*

* Extract from a paper which I read before the Troy Lyceum.

At the time when the Troy Lyceum authorized me to make an excursion through the eastern part of this state and into New-England, at the expense of this society, to collect geological facts and geological and mineralogical specimens, his honor John Lansing, Jr. L. L. D. late chancellor of this state, very emphatically expressed his approbation of this new mode of improving natural science. He then assured me, that he would, at his individual expense, cause a geological survey to be taken of the country to a considerable distance on the west side of the Hudson, whenever I could conveniently attend to it. Accordingly I set out on the proposed expedition on the 15th of last May, (1819) and returned on the 30th. During several days I was accompanied by the Chancellor, in person, and profited much by his reflections upon the various occurrences which appertained to the object of our researches.

In the side of a ledge of graywacke at a place called Bear's Ladder in Blenheim, near the west bank of Schoharie kill, I observed a series

It would be as difficult as uninteresting to discriminate, in this essay, between the observations of the Chancellor and of myself, made during the excursion. Though our opinions were often at variance, we reviewed, reconsidered and discussed, until we agreed on all material points.

The district of country which fell immediately under review, embraced a large proportion of the counties of Schoharie, Greene and Delaware, and a small part of the county of Albany. The basis rock between the rivers Hudson and Susquehanna is graywacke; and from specimens received, and former observations, I am authorised to state that the same stratum continues thirty or forty miles still farther west. Towards its upper surface this rock abounds in organic relics, which are mostly *pectinites* and *anomytes*. We found some *ostrea*, one *concha-venerite*, (as named by Le Sueur) and several other rare specimens.

We found no organic relics far below the surface of the graywacke. I believe they are rarely found at a great depth in this rock. In truth I have never seen *any* relics far below the surface of this rock, excepting an *orthoceria*, which was dug out of the argillaceous slate rock at the north end of this city. But Dr. Edwin James found petrifications of bivalve shells in what he considered as the argillaceous slate and transition lime rock near lake Champlain.

Imbedded in the graywacke there are vast layers of sandstone, of very different colours and textures. Some are coarse, being precisely the same aggregate as that from which the Nova Scotia grindstones are taken. Some are fine grained, and similar to the fine-grit grindstones used by carpenters. Some are even so fine that excellent hones for razors are manufactured from them.

of globular masses of well characterized graywacke, each three feet in diameter. They are composed of concentric spheres, one within another ; - and are set in firmly between two hori-

Along the bank of Schoharie kill, in the town of Blenheim, runs an extensive layer of sandstone, of a peculiar kind. It consists of fine particles of quartz, mostly cemented together by carbonate of lime and a little alumine, and is spotted with dots of red oxyd of iron. Three miles west there is a similar layer, several hundred feet higher. The latter has been wrought into very beautiful building stone ; specimens of which may be seen in the facings of several buildings in Albany.

On ascending the mountains, we always fell in with red sandstone ; and the highest mountains are often capped with breccia. This arrangement of strata is remarkably uniform throughout a district of country about one hundred and thirty miles from east to west, and, with a few exceptions, the extent is about the same from north to south. The red sandstone always alternates several times with the uppermost layers of graywacke before it becomes uniform. Towards the tops of some of the highest hills, we meet with breccia, resting on the different layers of red sandstone. I have often seen the breccia resting on the red sandstone and graywacke, forming those vast horizontal steps in Catskill Mountains, many hundred feet below other steps which were also composed of graywacke, red sandstone and breccia. Though I never traced the breccia so as to see that it was overlaid by the graywacke or red sandstone ; yet from a hasty view, these three strata seem to alternate with each other. At any rate, the red sandstone and graywacke certainly do alternate in every part of the district ; which forms a strong argument in favor of Bakewell's opinion, that the red sandstone ought to be placed in the transition class.

zontal layers of graywacke, like cheeses set vertically between the shelves of a pantry. All of them happen to be broken through their centres ; so that they present their concentric layers as distinctly as an onion cut through transversely.

The red sandstone throughout the whole of this vast district, contains that kind of organic relics, which is denominated *kalmiits* in the geological Index. From the reflections of Dr. P. S. Townsend, and from further examination, I am now inclined to consider it as a species of the genus *erismatolite* of Martin. As this genus is wholly of marine origin, all evidence that this stratum belongs to the secondary class seems to be removed.

Large boulders and blocks of compact shell limestone are found in various parts of this district. These are manifestly the remains of a broken down stratum, which once extended over a vast territory. In the vicinity of Hudson, Catskill, and some other places, extensive fields of this stratum still remain. These masses seem to have slid down from above the graywacke to a lower level, and often to have become concealed beneath the more recent alluvial deposits. The remaining monuments, which indicate the former existence and disintegration of the lime stratum, are numerous. The vertical cleavages of the graywacke are frequently lined with calcareous spar, or with perfect crystals of carbonate of lime. The perpendicular ledges are often faced with calcareous tufa, evidently dissolved and deposited by carbonated waters which have long since ceased to flow.

Throughout the town of Blenheim we find scattered blocks of gneiss and granite, similar to those found among the western spurs of Catskill Mountains, by Dr. Wells, and those which are so abundantly strewn over the counties of Albany and Schoharie.

Towards the top of a mountain nearly opposite to the last locality on the east side of Schoharie kill, about eight hundred feet above it, there is a horizontal layer of graywacke, which is pierced in all directions with holes resembling those in amygdaloid. The next layer above it contains *corallinites*. On comparing them I am inclined to believe, that the holes were caused by the decomposition of the animals under such circumstances as to leave the spaces occupied by them empty.

While I am on the subject of *corallinites* I would ask, whether those arboresecent white

The nearest primitive districts, from which these blocks could have originated, are the Highlands, and the range east of Pittsfield, in Massachusetts; the former about eighty, and the latter about seventy, miles distant, in a right line. Perhaps an accurate comparison of specimens might aid us in tracing these blocks back to their parent strata, and eventually lead to many interesting reflections. A fragment of about one foot by two, consisting of serpentine, containing greenish calcareous spar, beautifully crystallized and traversed by the amianthus variety of asbestos, was found near the northeast corner of Blenheim. Iron Pyrites and talc are disseminated through the serpentine. I never saw a specimen of this aggregate in the eastern range of primitive rocks; but it is very abundant in the Highlands. Therefore, until more facts are collected, I should be inclined to refer this mass to the latter range.

stripes, so common on the upper layers of graywacke, may not be the obscure petrifications of corallinites? I am aware that stripes, much resembling them, are very frequent in granular quartz, which is evidently primitive. And that it may be said we ought to presume that the same cause produced these appearances in both. But I have seen several specimens in graywacke, where those streaks were distinct cylinders easily broken out entire.

European books say, that graywacke passes into argillaceous slate. I adopted this opinion in the first edition of this Index, and was thereby greatly misled. There is a manifest distinction between rocks passing into, and alternating with, each other. After the most accurate examination of which I am capable, I discover no evidence of this fact. Near Troy are several remarkable localities, presenting the two strata distinctly at the place of their meeting. I find many layers of graywacke slate which are softer than any argillite. There is one locality near Schoharie kill about half a mile southeast of the mansion of Jacob Southerland, Esq. of Blenheim; and another in Carlisle, Schoharie county, containing the blue fibrous

fulphate of barytes. But in all these, the presence of those glimmering scales of talc forms a decisive characteristic. Though this variety is chiefly an argillaceous substance, in which there is more alumine than in argillite itself; yet its geological relations are very different, and it may always be distinguished in hand specimens by the shining scales. I have no doubt this is the soft argillite so frequently noticed in Indiana, &c. by Mr. D. Thomas.

This soft variety of argillaceous graywacke contains blue fibrous fulphate of strontian in Pennsylvania, according to Seybert.* But it is probably the same variety of fulphate of barytes above described; for this new variety deceived Cooper, Mitchill, Townsend, Low and several others, as well as myself; while we relied on its external characters. But an analysis readily detected the mistake.

The most beautiful large sized cubes of iron pyrites are found in graywacke slate and rubblestone. I have observed that it is most abundant in the lowest layers, or nearest to the argillite. In the parish of New Concord, Colum-

* See Cleaveland's Mineralogy. p. 127.

bia county, the radiated variety is very abundant. Mr. A. Cady presented a specimen from there to the Troy Lyceum, about two inches in diameter, which is a most perfect oblate spheroid. Anthracite, or glance coal, is found at Schuyler's quarry, and several other places in graywacke near Troy.

Graywacke is considerably metalliferous, but its ores are generally in the layers nearest to the argillite. The sulphuret of lead in Livingston's manor is said to be found in the upper layers of the argillite and in the lower layers of graywacke. The late Dr. Livingston of Hudson presented to the Troy Lyceum specimens of sulphuret of lead, contained in well characterized graywacke. This he found in place in the Manor, six miles east of Hudson River, and about the same distance west of the principal mine. The Rev. F. C. Schaeffer found sulphuret of silver and sulphate of barytes with the Manor lead.

In Blenheim on the south side of the Susquehanna turnpike road near the 43 mile stone is an extensive bed in graywacke of a substance, consisting of carburet of iron, black oxyd of

manganese and red and black oxyd of iron. The same substance is found in Rensselaer county and in Hillsdale in Columbia county, all in the same variety of graywacke.

I have in my possession a specimen of graywacke slate, which contains short crystals of sapphire. It was picked up on New-York Island by Dr. John Torrey about five years ago ; but, being thrown among unassorted minerals, was not noticed until lately. As there is not a known locality of sapphire in North America, it will be well to make further search among the graywacke.

The upper layers of the graywacke contain numerous organic relics. They are mostly the remains of extinct species of animals. Bakewell says the remains found in transition rocks “ may be regarded as ancient records, imprint-
“ ed with the natural history of the first inha-
“ bitants of the globe. We learn from the or-
“ ganic remains and impressions which these
“ rocks contain, that zoophytes and shell-fish,
“ which are considered as forming the lowest
“ link in the scale of animal creation, were the
“ first that received the gift of life.”

Graywacke, like argillite, does not contain petrifications in every part of any range. I have searched for them in vain for many miles. Then I have found immense quantities of them, in the very same rock, which, for a great extent, did not present a fragment. In Blenheim I procured for the Troy Lyceum abundance of *pectinites* and *anomites*, also a few *mytilites* and one *venerite*. *Trilobites* abound in the graywacke near Hudson. It is a remarkable fact, that the metallic substances are mostly confined to the lower, and the organic relics to the upper, layers of graywacke. The rubblestone variety, which is generally among the uppermost layers, contains the most relics in the loose fragments along the Schoharie kill in Blenheim, a little northerly from the mansion of Mr. Southerland.

As the graywacke abounds in sulphuret of iron, hepatic and chalybeate springs are not uncommon in it. From a hasty analysis, made in the open field, of the waters of a spring three fourths of a mile north of the toll-gate at the forty-third mile stone on the Susquehanna turnpike in Blenheim, I inferred that they were strongly charged with sulphate of iron and slightly with sulphuretted and carbu-

retted hydrogen. Infusion of galls gives dark purple in two minutes ; nitrate of mercury first gives a grey cloud then precipitates a black powder ; nitrate of silver gives a red colour in half a minute, which becomes darkish purple in five minutes. Neither barytic water nor oxalate of ammonia produces any change. The odour is that of sulphuretted and carburetted hydrogen. On drinking half a pint of the water I felt a sensation of dryness in the mouth and throat. A disagreeable sensation in the stomach and pain in the head ensued. It is used by those who reside in this vicinity, as a cathartic, and as an anti-scorbutic wash. It issues from a cleavage in the graywacke rock 50 feet below the top of the ledge.

I have detained the reader with a more particular description of this spring, than comports with the plan of this Index. But as springs, in their sensible qualities resembling this, frequently occur in this graywacke region, this may serve for a general description of the whole.

STRATUM 10.

RED SANDSTONE.

THIS is the old red sandstone of Werner, which he places in the secondary class; but Bakewell places it in the transition class. I have given my reasons for following Bakewell in the Grammar of Geology. M'Clure was inclined to place it here after taking a most extensive view of the geology of the United States;* and I have no doubt but every American geologist will finally adopt his opinion.

I expected to see some pretty large patches of red sandstone set down on the geological map of Messrs. Danas; because I saw loose fragments of it in the vicinity of Boston, particular-

* See American Journal of Science, p. 212.

ly about Charlestown. But they did not discover any, which they deemed worthy of a place in their treatise.

In the Connecticut river range, the red sandstone is pretty extensive. It alternates with graywacke below Northampton, as in Catskill Mountains. I have traced it from Greenfield, Mass. to New-Haven. It follows the course of Connecticut river as low as Middletown. The river inclines to the east, cutting its way through the primitive rocks, from that place; leaving the red sandstone to continue its course to Long-Island Sound. It is several miles in breadth all its way across the state of Connecticut. It passes under and supports a range of greenstone trap hills from Deerfield to New-Haven. West of Hartford it passes under the greenstone ridge and appears again in the banks of Farmington river; and it holds this breadth in the narrowest part, in a southern direction to the Sound.

Returning to the state of New-York, we find it a very important stratum. The range on Hudson's river below the Highlands at Tappan bay, is well known; but I have no know-

ledge of its having been traced to any considerable distance northerly, or northeasterly. Dr. Akerly has traced it along under the greenstone trap from below Haverstraw to Fort Lee, thence through most of the state of New-Jersey.*

As was observed under the description of the graywacke, it alternates with the upper layers of that stratum all the way from the east face of Catskill Mountain to about thirty five miles beyond the Susquehanna. At a place two miles north of Durham street, Greene county, the red sandstone descends even to the bottom of a valley ; but it is generally confined to the highest elevations. There are several fields of it, which appear as though they had been undermined by the disintegration of their supporting graywacke and tumbled down many hundred feet. There is one hill of this description of the brittle flaty kind, a little north of the mansion of John Livingston, Esq. nearly opposite to Catskill ; another a few miles east of Kinderhook ; another of great extent about a mile northeasterly from the residence of Neri Stoddard, Esq. in Cairo, Greene county.

* See the Geology of the Hudson River, by Dr. S. Akerly

The layers which alternate with the graywacke are always harder than those above, where the red sandstone becomes uniform. There is a mountain in Blenheim, called Mineral Hill, which is almost wholly red sandstone for several hundred feet in thickness. This is of about as soft a texture as that of the Tappan range; consequently may be denominated red freestone.

It is remarkable, that where the graywacke dips beneath the upper strata, the red sandstone disappears with it, or in a very small distance. But both these strata seem to be laid bare at intervals very far to the west, in the compact limestone region. Mr. M'Conihe saw it in Indiana in some deep ravines and ledges, and Mr. Schoolcraft saw it in the banks of the Mississippi. At the bottom of the Niagara Falls it appears, alternating with the brittle flaty variety of graywacke, as in Catskill Mountains.* It

* See Dr. Mitchill's appendix to the New-York edition of Cuvier's Theory of the Earth, p. 352. The arrangement of rocks at these Falls demonstrates the importance of considering strata on a large scale. Because from this local view it would appear, that this variety of friable graywacke held its place in the system next to compact limestone, and above red sandstone. Whereas

appears also along the shores of Lake Ontario, of Oswego river, &c.

Bakewell says, page 112, that coal is never found below red sandstone, and that metals are never found above it in the *form of veins*. I do not know, that these declarations have been corroborated by researches made in our district.

A peculiar kind of organized remains is very common in the red sandstone of our district. The best localities, to which I can refer the reader, are, at the Mineral Hill in Blenheim, and one mile south of the upper lake on Catskill Mountain, about one mile east of Edwards' sawmill at the outlet of the lower lake. These relics require particular notice.

Jamelson, in his notes to Cuvier,* says;
 "The red sandstone contains but few petrificac-

any one, who climbs the numerous mountains of Greene, Schoharie and Delaware, will learn, that the upper layers of the graywacke always alternate several times with red sandstone before we come to the compact limestone. And that sometimes the friable variety of graywacke will happen to be uppermost next to the limestone. I have seen two such localities in Columbia county. One at Becraft's Mountain, and one in Claverack.

* See New-York edition of Cuvier's Theory of the Earth, page 221.

“ tions, and these are principally of trunks or
“ branches of trees, some of which appear to
“ resemble those of tropical regions.” I adopted
this opinion on my first examination of these
relics. The roots of the *kalmia latifolia* (common laurel) are of the closest texture and finest grain, perhaps, of any frutescent plant in the northern latitudes. Pieces of these petrifications several feet in length may be seen in great quantities at both these localities, which present a striking resemblance to the roots of this shrub. But on tracing several specimens to their natural terminations, they appear to end like the terete posterior extremity of the common earthworm, or angling worm. I deposited a very perfect specimen of this description in the Troy Lyceum. After a very attentive review of thousands of these petrifications, I am convinced that their prototype was not any species of plant with which I am acquainted ; and I am inclined to refer them to the tribe of naked vermes ; notwithstanding they present arboresecent plant-like appearances. I say naked, because there is not a particle of carbonate of lime embraced in them. But they are perfect substitutions of sandstone, though much finer grained than the enclosing rock. They are from one inch in di-

ameter to the size of a small goosequill. I have traced some of them ten or twelve feet in a serpentine course, without finding a natural termination, and sometimes without discovering much difference in the diameter. Their texture sometimes appears a little fibrous, and often presents the appearance of concentric layers. Though their natural form is terete, they are often much compressed.

They are not confined to the plane of the layers of the enclosing rock ; but often penetrate it obliquely. Several branches originate from a thick stock in some specimens like roots from the bottom of a stump.

Not many ores have been discovered in the red sandstone of our district. Antimonial copper ore was found in it near Hartford, Con. by M'Clure ; and both the red oxyd and carbonate of copper in New-Jersey by Gibbs.

Many profitable quarries of this stratum are wrought in our district. That at Tappan on Hudson's river and at Chatham on Connecticut river are among the best. Many others might be wrought which are overlooked, in various parts of the state of New-York.

III. SECONDARY CLASS.

*Introductory Remarks from Bakewell.**

“ AS there are indubitable proofs that water once covered all the existing continents, it follows that, when the ocean retired, or, which is the same in effect, when the dry land emerged from the sea, vast inland seas or lakes would be left, at the bottom of which the SECONDARY STRATA were formed.

“ As the sea retired further, the higher grounds being left dry, these large inland seas or lakes would be contracted, and a number of

* See Bakewell's introduction to Geology, pages 227, 228, 234—237, second London edition. Not being an advocate for any geological theory, and wishing to present the least exceptionable one to the reader, I have selected these remarks from Bakewell.

smaller insulated lakes would occupy the lowest cavities and depressions; in each of which separate depositions of strata might take place. The lower strata would therefore be the most widely spread, and the upper would constitute independent or *local* formations of greater or less extent, in which there might be great similarity in some situations, and much diversity in others. Now such is found to be the fact. The above I consider not as hypothetical assumptions, but as legitimate inferences from indisputable facts, which will go far to explain the formation of the upper surface of the globe in a simple and intelligible manner, consonant with its present physical structure.

“ On the continent of America, nature acts upon a magnificent scale. Were her operations attended to, they might illustrate many interesting facts in geology. Since the banks of the cataract of Niagara were inhabited by Europeans, they have observed that it is progressively shortening the distance from Lake Erie to Lake Ontario. When it has worn down the intervening calcareous rocks and effected a junction, the upper lake will become dry land, and form

an extensive plain, surrounded by rising ground, and watered by a river or smaller lake, which will occupy the lowest part.

“ In this plain future geologists may trace successive layers of fresh-water formation, covering the subjacent limestone. The gradual deposition of minute earthy particles, or the more rapid subsidence of mud from sudden inundations, will form different distinct beds, in which will be found remains of fresh-water fish, of vegetables and of quadrupeds.*

“ Large animals are frequently borne along by the rapidity of the current, and precipitated down the cataract. Their broken bones mixed with calcareous sediment, may form calcareous rocks where the waters first subside after their descent. Bones of quadrupeds are found thus intermixed in the calcareous rock at Gibraltar.

“ Perhaps there was a period when the branches of Mount Atlas in Africa were united with

* Myron Holley, Esq. after four years of attentive observation in the western part of the state of N. York, while Acting Canal Commissioner, is strongly inclined to this theory of local formations.

the mountains of Spain, and the Mediterranean mixed its waters with the Atlantic through a narrow passage like that of Niagara. These two seas would then have a different level, and a stupendous cataract might exist near the rocks of Calpe, and bury under its waves many of the animals that attempted to cross the current.

“ From the intermixture of these bones with calcareous sediment, the present rocks with their osseous remains, may have originated. And these calcareous strata may have been raised to their present elevation by a sudden subterranean explosion, which opened a passage for the waters of the Atlantic, and reduced both seas to their present level.

“ I believe, that an enlarged view will be sufficient to prove that all the stratified rocks above red sandstone, are local formations, which had their origin in detached hollows or seas of great extent, and are limited to certain portions of the globe.”*

* See Dr. Mitchill's remarks upon the ancient barriers in our district, in his appendix to Cuvier's Theory of the Earth.

STRATUM 11.

BRECCIA.

THIS stratum, like the red sandstone, seems not to be universal, in its proper geological place. But it is rarely wanting where the red sandstone is present. In our district it is chiefly confined to the Connecticut River range, and to the graywacke region in the state of New-York. It is the only secondary stratum, which I have seen in place east of the state of New-York. I have lately been told however, by an intelligent young man, that not only graywacke, in which the grindstone beds are found, but compact limestone and gypsum also, appear in the same order of succession in Nova-Scotia, as in the state of New-York. Mr. Hitchcock presented to the Troy Lyceum a specimen of bituminous shale with an impression of a fish,

which was taken from Connecticut river near Deerfield. Similar specimens have been found at the Rhode-Island coal mines and at Middletown, Con. But I do not consider this shale or coal as entitled to a place among regular strata. *They* are unquestionably local formations; whether Bakewell's theory in relation to *all* secondary rocks be received or not.

It is a misfortune to this part of the science of geology, that breccia is so often confounded with both red sandstone and puddingstone by American geologists. Breccia in our district always rests upon red sandstone and is generally reddish. Puddingstone has no conformable position; and it consists of mere masses of gravel cemented together, generally by carbonate of lime. Breccia, in the Connecticut river range and in the graywacke region in the state of New-York, is made up of fragments of primitive rocks; mostly of gneiss rocks. Puddingstone, wherever I have examined it, consists of pebbles of graywacke, argillite, milky quartz, or of whatever constitutes the gravel of that immediate vicinity.

It is a remarkable fact, that, notwithstanding the breccia of Catskill Mountains is separated

from the primitive rocks of Massachusetts by twenty miles of argillite which contains immense quantities of milky quartz, it does not contain either argillite or milky quartz. I have examined the breccia on the highest part of Catskill Mountain, near the Delaware and Susquehanna rivers, in Blenheim, and many other towns; and I find it contains a large proportion of that translucent variety of quartz which forms a constituent of granite and gneiss. The Connecticut river range differs only in containing more felspar, and in being generally more friable.

I regret that I am not able to give a more distinctive characteristic for this stratum. For although I am never at a loss in distinguishing it from the old red sandstone when I see it in place, I have not seen a satisfactory definition of it; neither am I able to supply one. It always contains rounded pebbles; or at least rounded pebbles may be found within a few feet of any assumed point. It is said that the old red sandstone sometimes contains rounded pebbles also; if it does, such pebbles are certainly not common. The breccia is always the

uppermost rock ; and, though frequently red and in some parts made up of fine grains so as to resemble the red sandstone, if it is examined to the extent of a few yards, the evidences of its recent formation will become manifest. On Catskill Mountain, one mile south of the upper lake, the breccia has crumbled off at its under side, so that a man may pass between the breccia and red sandstone about twenty feet into the ledge. Similar appearances to a less extent are very common all the way to Susquehanna river, wherever the breccia caps the high cliffs.

The bones of land animals and other relics found beneath what I denominate breccia, near Tappan,* demonstrate this rock to be more recent than the old red sandstone of Catskill Mountains. But the best locality within my knowledge for elucidating this subject, is that which has attracted some notice at Ketch Mills six miles northeasterly from East-Windsor church, Con. I had examined this range of red sandstone and breccia before the late discovery ; but I have since taken means to have it re-examin-

* See Akerly's Geology of Hudson's river.

ed with great care. Mr. Henry Newbury, a gentleman of respectable scientific acquirements, and the Rev. Sylvester Eaton, made a personal examination of it on the 15th of the present month (April 1820) from whom I received the following account.

The discovery of the remains of bones, supposed to have belonged to a land animal, was made by workmen while digging a well. They dug through five feet of alluvial earth, when they came to a reddish rock, into which they penetrated sixteen feet. The rock is made up of several different layers, and the relics are found in the lowest one. Some of the layers are as well characterized breccia, as any specimens in the Lyceum. Others are finer grained, and appear like red sandstone. Some specimens present the characteristics of breccia on one side and of red sandstone on the other. But rounded pebbles, often as large as a goose-egg, may be found more or less in all the layers. That in which the bones are embraced is pretty fine-grained generally; but rounded pebbles are found in all the fragments, now lying about the well, which contain bones. The workmen

who dug the well, say that the rock was easily penetrated, excepting some of the layers which were made up of quartz pebbles.

From the above account it is evident, that a rock which is demonstrated to be of recent formation by its enclosed relics, often presents appearances nearly similar to the old red sandstone. But that on a more extended view, the large rounded pebbles prove it to be breccia.

The proper breccia is interposed between the red sandstone and superincumbent rocks at Northampton and Deerfield; and it would probably be found beneath every locality of these rocks if we could have access to their bases. Wherever the breccia reposes on red sandstone in steep ledges, the distinction between the strata is as striking as between the former and basalt.

Several aggregates are denominated breccia, which have no connexion with this stratum. Calcareous breccia, the *nagelfluh* of Werner, is connected with the compact limestone in our district. There is one locality two miles south of the city of Hudson adjoining the west side

of South Bay road, and another two or three miles northwest from a place in Chatham, Columbia county, called Federal Store. In Ulster county the quartzose breccia is manufactured into millstones. Mr. Olmsted, a student in Yale College, presented to the Troy Lyceum a beautiful specimen of agate breccia or silicious breccia, which he found two miles west of New-Haven. It consists of semi-opal and chalcedony. The nagelfluh or calcareous breccia, which has been applied in building the Capitol of the United States, is well known. But all these should rather be denominated breccioids than breccia ; as they have no connexion with the stratum.

STRATUM 12.

COMPACT LIMESTONE.*

I BELIEVE there has never been even a fragment of compact limestone discovered in any of the New-England States, excepting along the shores of Lake Champlain in the west margin of Vermont. It forms the basis rock, however, of more than half the territory of the United States.

In our district, and probably in every part of North America where it occurs, it is evidently made up of organic remains; chiefly of bivalve shells. A little aluminous and silicious earth is frequently combined with it. • It is a remarkable fact that much the largest propor-

* Is not this the *Lias Stratum* of Europeans? See Rees' *Cyclopedia*, Vol. 41, Part 2, word *Geology*.

tion of this vast stratum is composed of two species of shell—the *anomite* and *pectinite*. In this estimate I follow the arrangement of Linneus, Martin and others, who consider the *terebatulite* and *grypbite* as sub-species. I think I may say with confidence, that the remains of two GENERA of animals, *Anomia* and *Pecten*, form at the least two thirds of all the secondary lime rocks in North America. It may be deemed arrogant to include *all* the territory of this vast continent. But it has been my good fortune to see specimens of this rock from Canada to Mexico, and from Hudson's river to the Mississippi, taken from numerous localities. Perhaps I ought not, however, from these examinations to infer, that there may not be compact limestone of great extent made up of different organic remains, west of Rocky Mountain.

In our district it always rests upon red sandstone or breccia, when these strata are not wanting. If these latter strata are wanting, the compact limestone rests on graywacke. Mr. Schoolcraft always found it overlaying sandstone in

Missouri.* Dr. E. James found it resting upon breccia near Ticonderoga. In the Heldeberg it invariably lies immediately upon sandy graywacke; and there is no red sandstone nor breccia present.

The order of the formations is very well illustrated by the situation of this lime rock in the graywacke region, between Massachusetts and Susquehanna river. For though it is frequently found thousands of feet lower than the tops of the mountains of graywacke, it is never under it. But it uniformly retains its superior geological position, from the lofty cliffs to the lowest valleys.

About two miles east of Hudson city is a field of compact limestone four or five miles in length and about a mile in breadth. It is completely insulated, and rests upon an insulated hill of graywacke. For the graywacke is disjointed from the stratum to which it belongs, and lies upon argillite. Some part of this lime

* See his view of Missouri mines, pages 199 and 228. The sandstone, not red, which he observed, is probably an upper layer of graywacke, or graywacke passing into sandstone, similar to that in the Heldeberg, Catskill Mountains, &c.

hill is sufficiently compact for marble. Col. Darling of Hudson has wrought some of it into most elegant chimney-pieces. The variegated hues, arising from the colouring matter of the various organized substances still remaining, have a beautiful effect. The polish, given by the artist, tends to present the organic remains more clearly to view. I saw the most perfect forms of the *anthocephalite* (caryophyllite) and *encrinite*, I had ever seen, in one of these polished slabs.

Northwest of Catskill village, along the Susquehanna turnpike, is another large field of shell limestone on graywacke ; and from two to three miles west of the village is another on the Little Delaware turnpike. Perhaps it would be more proper to say, that the range of compact limestone, which crosses Glen's Falls in Saratoga county, continues down along the top of the graywacke ridge through the west part of Schenectady county, the Heldeberg, Rensselaerville, Coeymans, Greenville, Hudson, Catskill, Kingston, Marlborough, &c. It is not a continuous stratum now however. It is rather a range of insulated fields capping the hills of graywacke.

It is generally composed of a pretty loose aggregate of bivalve shells; though in many places it is sufficiently compact to be wrought as marble. At Coeymans it has been wrought as well as at Hudson. A few miles below Albany a quarry has lately been opened, which promises much usefulness.* In truth it may almost always be wrought at the depth of a few feet, where the shells have been pretty thoroughly disintegrated.

Although this stratum is more continuous in the western part of the state of New-York and in all the western states than in the vicinity of Hudson's river, it is often interrupted by creeks and valleys in those regions. Wherever it is cut through, either the red sandstone, breccia, sandy or brittle flaty graywacke, invariably appears.†

* Dr. T. R. Beck.

† Extract from Mr. Henry R. Schoolcraft's communication, which was read before the Troy Lyceum.

“ I consider the present classification of secondary and alluvial formations as the most defective and unsettled part of geological science; and confess myself unable to furnish many facts on the subject.

The proper country for the study of this stratum is the graywacke region between the Hud-

“ Our theories should be the result of observation, and facts should never be distorted by theory. I have endeavored to adhere rigidly to this principle in all my researches. In my tour through the valley of the Mississippi I collected some facts with a view to a geological map of that country ; but I have said little upon the subject, wishing for more time for observation and reflection.

“ I saw no gypsum in Missouri or Arkansaw in *situ*. The vast bodies of selenite, (crystallized gypsum) reported to exist near the Grand Saline, on the Arkansaw, I mentioned on the authority of Mr. Sibley, of St. Louis. He made a personal examination, and brought away several beautiful specimens. He gave no particulars respecting its geological situation, which are sufficiently precise to be of any service in a scientific point of view. In Illinois I saw small quantities of crystallized gypsum, resting in detached flakes upon secondary limestone, and also forming small layers in it.

“ A sandstone stratum is very extensive in the valley of the Mississippi. It is sometimes mixed with calcareous particles sufficient to exhibit a slight effervescence with muriatic acid. [See note to page 224] It is the basis on which the secondary limestone of Ohio, Indiana, Illinois, Missouri, part of Kentucky, Tennessee, and Arkansaw, rests. It is the lower rock which is sometimes seen a few feet above, and sometimes a few feet below, the water on the banks of the Ohio, Mississippi, Arkansaw, White river, St. Francis, Black river, Gasconade, Merrimack, and other streams running into the Missouri—all of which I have particularly examined.

“ Along the banks of the Ouachitta, in Arkansaw territory, we find slate pervaded by large veins of common quartz rock. I

fon and the Susquehanna. Here may be found hundreds of patches and fields of it ; sometimes

have not been far enough towards the territories of New-Mexico to speak of the mineral physiognomy of that section of country. Neither have I travelled a sufficient distance towards the Rocky Mountains to give an account of its geological character, nor how far its primitive spurs (if primitive) may reach towards the east and north.

“ The secondary limestone, which characterizes Western America, is so vast, so illimitable, as to weary the patience, if it does not drain the pockets, of the travelling geologist. It extends far beyond the present settlements, into regions known only to hunters and savages.

“ The insulated ridge of granite, which I have noticed in Madison and Washington counties, Missouri, is an object of the highest interest. Surrounded by hundreds, and I might say by thousands, of miles of secondary rocks, here reposes one of the oldest of the primitive rocks—old red granite. The pinnacle of a primeval mountain, nearly submerged by more recent deposits, now hardened into rocks. Viewed in connexion with the surrounding country, it appears to me to present some unanswerable arguments in support of that theory which ascribes the formation of the earth chiefly to the agency of water. If the Wernerians would frankly admit the partial agency of fire, no force of reasoning appears capable of disproving the doctrines they teach.

“ From the north of this granitic tract extends a range of granular quartz, maintaining a parallelism with the Mississippi for about 40 miles. This is occasionally broken by rivulets, and terminates or disappears near the banks of the river, between St. Genevieve and Herculaneum. A stratum of limestone, more extensive than the granular quartz, *without organic remains*, extends west of it so far as to embrace the lead mines of Potosi.”

capping the highest mountains, sometimes in a state which clearly indicates its having slid down from higher elevations, and sometimes in boulders and blocks intermixed with alluvion. Its former existence is often testified by small pebbles of it intermixed with pebbles of other secondary rocks ; and by its serving as a cement in the formation of puddingstone. A very perfect locality of this kind of puddingstone is presented in the bank of alluvion at the southeast part of the city of Troy. It was a very important suggestion of Bakewell, that every stratum must have had its turn of being the uppermost of all strata. When the compact limestone stratum was uppermost, there must have been much silicious matter in a state of solution ; for it is every where pervaded with the most perfect hornstone. I have seen layers of it more than 20 feet in length and two inches thick near Bethlehem caverns, Albany county, some of which contain petrifications. I found several specimens at the same locality, which I deposited in the Troy Lyceum, containing globular masses an inch in diameter of a lighter colour than the encasing hornstone. I consider these as nodules of real flint.

That this stratum recently formed the bed of the ocean is manifest, from its being chiefly made up of oceanic relics. But whether the "mighty waters retired," two, three or four thousand years ago, I presume we shall never be able to ascertain from any evidence presented by these petrifications. Dr. Mitchill observes, "On viewing these productions, the mind endeavors to fix that unascertained time, when the oceanic waters of the primitive globe rolled over this region."

This is the only cavernous stratum in North-America, and probably in the world. A few caverns have been found in other strata; but they generally depend on accidental disruptions or particular disintegrations. This is the only stratum whose very structure necessarily renders it cavernous. When the waters of the ocean retired, the calcareous cement, which now holds the shells together, was in the state of a soft paste. This may be proved by producing an artificial solution and proving by experiment, that it will not harden under water. After the waters retired, the parts exposed to the sun's rays began to harden, contract, and crack into

blocks. In some parts of the Heldeberg these blocks are of great extent ; but I have seen acres of it where the stratum is very thin, chequered up into blocks from two, to ten, feet square. Where the stratum is very thick and the fissures very long, large caverns were frequently formed. For the upper surface of the stratum was soon dried and indurated ; while the whole remained soft a long time a few feet below the surface. If a stream of water happened to flow in the vicinity of a fissure, it would probably make its way into it, and soon wash away the loose shells beneath the surface which were merely enveloped in soft calcareous paste.

I have examined four of the largest caverns in the Heldeberg, and they all still exhibit conclusive evidence of their having been once in the state of mere fissures ; and streams of water still traverse them all. The largest of these caverns is the great cave at Bethlehem, twelve miles southwest from Albany. This is a few feet more than the fourth of a mile in length.* Throughout its whole extent we can trace the

* It was accurately measured by my brother, Rev. Sylvester Eaton.

fissure overhead ; though the edges of the rocks above have pitched in against each other so as to close it.

The vast caverns of Kentucky containing nitrate of potash and nitrate of lime, described by Dr. Samuel Brown, of Alabama, and Mr. W. B. Stilson, are in the same stratum. Also those of Tennessee described by the Rev. E. Cornelius and by Mr. J. H. Kain. Mr. M'Conihe found many vast caverns and subterranean avenues in Indiana, all in the compact shell limestone. But there are no caverns in what is called the water-limestone, which on being made into a paste hardens under water. This substance will be described under secondary sandstone.

Mr. M'Conihe discovered an extensive layer of the true white lithographic stone in connexion with the compact limestone in Indiana. He has deposited small specimens in the Troy Lyceum, precisely resembling that which Dr. Samuel Brown considers as the most perfect variety.*

* Dr. Brown showed me a specimen of the stone, with specimens of Mr. Otis' beautiful lithographic drawings. He would find abundant materials for this use in Indiana.

It has long been a subject of general remark, that no chalk is to be found in North America. But Mr. Schoolcraft found it in abundance along the banks of the Mississippi, between the mouths of the Ohio and Missouri. - It is in connexion with compact limestone, and contains flint nodules.*

The concentric globes of carbonate of lime, constituting a part of the rock of Gibraltar, are well known. Dr. Steel presented to the Troy Lyceum hemispheres of similar conformations, which he found near Saratoga Springs. They are three and four inches in diameter; but coarse-grained, grey, and not variegated like those from Gibraltar.†

Coal is found in connexion with compact shell limestone in the western part of the state of New-York. Mr. C. Atwater found it in the same connexion in the state of Ohio. Mr. David Thomas observed it in many localities in the

* See Schoolcraft's View of Missouri Mines, pages 180 and 227.

† These masses or nodules seem to belong to Cleaveland's subspecies, CONCRETED CARBONATE OF LIME.

Western States—always in connexion with the shell limestone. The slate which he saw in connexion with it was unquestionably the bituminous shale, which generally overlays coal.

This stratum is not metalliferous. Mr. Schoolcraft found jasper in it in Missouri, and nitrate of potash crystallized in crevices along extensive rocks.* Very few imbedded or disseminated minerals, however, are found in it; excepting the various forms of calcareous crystals, and rarely a little sulphate of lime.

Before I dismiss this stratum, I will extract, from the transactions of the Troy Lyceum, an article respecting the discovery of sulphate of strontian. “Mr. William A. Bird, the surveyor who accompanied Gen. P. B. Porter in running the boundary line between the United States and Canada, has returned with many interesting facts and specimens collected about the head of St. Lawrence and the Lakes Ontario and Erie. He discovered, in company with Capt. Douglas of West-Point, a new locality of a mineral, which, by the experiments of Mr.

* See pages 206 and 208, View of Missouri Mines.

Amos Eaton, performed before the Lyceum, proves to be crystallized sulphate of strontian.

“ As several minerals have been taken for sulphate of strontian, which were afterwards found to be barytes ; and as it is doubted whether there is any such mineral in North America, it may be proper to give Mr. Eaton's tests and experiments. He fused it and exhibited the purple flame before the blow-pipe. The melted globule gave a sour taste ; though after four hours it fell to powder and gave the taste of sulphuretted hydrogen. He formed a muriate of it, which gave a blood-red flame, both in a dry powder and dissolved in alcohol, when applied to a candle wick. Its specific gravity appears to vary from 3.79 to 3.96, by repeated trials made by Drs. Wells and Hale ; but most of the specimens gave 3.85. It is the foliated variety, always translucent and often transparent. Colour hyaline, often shaded with blue. Lustre strong and frequently iridescent. The crystals are mostly tabular with many oblique re-entering angles, presenting a striated appearance. Some crystals are rhomboidal prisms with two opposite truncated angles. This mi-

neral is found in compact, and shell limestone, on Mofs Island, in Lake Erie, two miles west of Put-in-Bay."

Dr. John Torrey of New-York, has since analyzed this mineral and produced the same results, with several additional ones; demonstrating it to be crystallized sulphate of strontian. This is the only locality of crystallized sulphate of strontian discovered in North America. It is doubtful whether any variety of this mineral has been discovered before in this country; though several localities have been publicly announced.

STRATUM 13.

GYPSUM.

IT is the opinion of many geologists, who have carefully studied our western rocks, that gypsum ought rather to be considered as forming beds in compact limestone, than as constituting a stratum. My knowledge on this subject is too limited to authorize an opinion. I shall therefore follow those, who treat it as a stratum.*

* Extract from a paper read before the Troy Lyceum by Isaac M'Conihe, Esq.

" My route was nearly through the centre of the population of Indiana, though far south of the centre of the territory. It is the general understanding in the eastern states, that all the western part of the United States is of an even surface. Such at least was my impression, when I set out to journey to the west. Such is very generally the fact throughout much of the vast valley of

GYPSUM.

The gypsum of our district is remarkable for its dark brown and black crystals, or black se-

the Mississippi. But the part of Indiana through which I travelled is as hilly as some parts of New-England, though the hills have mostly rounded summits, and are denominated knobs by the inhabitants.

" This is evidently a secondary country; though transition rocks often appear. In fact, evidences occur at irregular intervals, sufficient to lead the mind to the conclusion, that the whole country is underlaid at no great depth, with a continuation of the transition rocks which predominate in the vicinity of Hudson's river in the state of New-York. I found one locality of well characterized argillite at the bottom of a creek. This was among that range of hills, which commences at New-Albany, about six miles from the Ohio, and continues fifty or sixty miles. Along the eastern edge of this range of hills, the red sandstone prevails, often of that hard flaty variety, common in Catskill Mountains. Detached masses of graywacke frequently occur here also. Whenever these transition rocks appear, the circumstances attending them and their geological connexions clearly indicate that they are left in view, by the disintegration of the secondary rocks, which had once overlayed them.

" Vast horizontal layers of secondary limestone are extended over most of this state, which abound in organic relics. These relics are most abundant, however, in some particular localities. In what is called the Barrens of Washington county, *Madreporites* of the horn-shaped variety appear in thousands. *Pectinites*, *Anomites* and *Terebratulites* are found in every place, where there is compact limestone.

" About fifty miles from the Falls of the Ohio there is a locality of remarkably compact, fine-grained, variegated limestone.

lenite. Carbonate of lime is frequently blended with it, even in its most extensive localities ; so that it often effervesces with acids.

It is remarkable that, though the brownish grey gypsum of Nova-Scotia gives a white streak, the same coloured gypsum of the state of New-York gives a grey streak. This fact was first noticed by plaster grinders. They observed that the same coloured gypsum, which, if

Alternating with its layers I found large quantities of the true white lithographic stone ; now becoming a very important mineral, since Dr. Samuel Brown, of Alabama, introduced the lithographic art into this country. I have deposited small specimens of it in the Troy Lyceum.

“Near this place workmen were engaged in digging a well. I took specimens from the fragments of two rocks, which seemed to be in place about thirty and thirty-five feet below the surface, and merely noted down their relative positions and locality. On examining them since, I find the lower rock to be *gypsum*, overlaid with secondary calcareous sandstone.

“The lime rocks of this state are remarkably cavernous. There are several pretty large streams of water, which disappear for miles through the vast fissures and cavities in these rocks. There is one, whose return to open day has not yet been discovered.

“In the alluvion I found well characterized fragments of agate. Also chalcedony, semi-opal and fine sinople jasper.”

from Nova-Scotia gave a white flour, would give ashes-coloured flour if it was obtained from the west.

Gypsum is very abundant in the counties of Madison and Onondaga, New-York ; particularly in the towns of Sullivan, Manlius and Camillus. Mr. D. H. Chapman presented fibrous gypsum of the most beautiful kind, which he obtained at Manlius. The fibres are four inches in length, a little curved, of a pearly white colour, and of much firmer texture than the specimens from Nova-Scotia.

I have not been informed of the discovery of any organized remains in the gypsum of the west ; though it is overlayed with, and is reposed upon, strata which abound in them.

Sulphate of lime is frequently found attached to other rocks in small specimens. These ought to be called sulphate of lime merely, not gypsum ; because the latter name is calculated to excite false expectations. Wherever the soft granular variety of iron pyrites is disseminated in carbonate of lime, the pyrites becomes de-

composed on exposure and sulphate of iron is produced. Whenever the latter substance is washed down on the surface or in the fissures of carbonate of lime, the carbonate is decomposed and the sulphate is produced. Dr. Mitchell observed this process going on at Niagara Falls. I found a graywacke ledge faced with this formation of sulphate of lime in Blenheim on the west bank of the Schoharie.

I have never been informed of any anhydrous gypsum in our district. Neither have I seen any sufficiently white and compact to form alabaſter.

It appears from the observations of M^cClure, Mitchell, Mr. Caleb Atwater and others, that rock-salt accompanies the gypsum along the great range which extends from Onondaga lake to the state of Tennessee. M^cClure observed the same connexion in Poland, Europe.

Since I wrote the above, I received a letter from Austin Abbott, Esq. the Corresponding Secretary of the Hudson Scientific Association,

assuring me, on the authority of Walter Patterson, Esq. that patches of gypsum are sometimes found on the compact limestone ridges near Ancram furnace, in Columbia county.

STRATUM 14.

SECONDARY SANDSTONE.

I REGRET that it is not in my power to present the reader with many facts, relating to this stratum, which have fallen under my *own* observation. I have received no evidence of its existence east of the river Hudson ; though it appears to be of great extent to the west.

This stratum had never been described to me, neither had I seen a specimen in any cabinet, when I visited a locality of it on the Heldeberg, in company with the President of the Troy Lyceum and Dr. T. R. Beck. We were perfectly at a loss in labelling our specimens taken from this rock ; neither did we then settle its geological position. After two more visits in company with several members of the

Lyceum, and after attentively reading Bakewell's description of several varieties of secondary sandstone, as well as those of other European geologists, we ventured to denominate it Secondary Sandstone.

It is chiefly silicious and very fine grained ; rarely containing carbonate of lime sufficient to effervesce with acids. It is grey, yellowish or brownish. The best locality in the Heldeberg is a little east of Pucker-Street ; where the rock is divided by open fissures or seams into pretty regular blocks. These fissures appear like artificial cuts ; and the blocks present faces almost as smooth as if wrought by the chissel. This rock abounds in organic remains, apparently of more recent formation than those in compact limestone. Culmiferous petrifications frequently occur, and the animal remains are often easily separated from the rock in a very perfect state.

It rests upon compact limestone generally. I found one locality however, where the limestone was wanting for several feet ; and here it lay immediately on the sandy graywacke, which underlays the limestone. The floor of a cavern

two miles north of Pucker-Street is graywacke, the walls are compact limestone, and the covering is secondary sandstone abounding in *favosites* and *encrinites*.

From the observations of geologists, who have travelled in the western country, I am inclined to consider the secondary sandstone of the Heldeberg as the lowest layer of this stratum, which may have been once covered with several others. And I am inclined to believe, that future observations will demand a subdivision of this stratum into three or four. It is probable that at least one of these subdivisions ought not to be called sandstone. But I prefer treating them as subordinates or varieties, to running the risk of creating untenable subdivisions.

I am indebted to my friend and class-mate, Myron Holley, Esq. Canal Commissioner, for the most important facts respecting this stratum. In consequence of the enquiry, which the Heldeberg locality and some specimens brought to Albany by Mr. Holley in the winter of 1819, had excited, he studied this stratum attentively, while engaged in his official duties along the great Western Canal. He observed it all the way from near the east bounds of Madison coun-

ty to the west bounds of Niagara, a distance of almost two hundred miles. It generally rests upon shell limestone, where its supporting stratum is in view. Wherever the gypsum occurs, it invariably lies beneath this stratum. He refers more particularly to the gypsum beds in the towns of Sullivan and Manlius. He presented specimens to the Troy Lyceum, which are similar to those which Mr. M'Conihe found overlying gypsum in a well in Indiana.

Wherever Mr. Holley observed the order of the layers constituting this stratum, particularly where the works on the Canal required that they should be cut through, they were found as follows. The uppermost layer is very coarse sandstone or gritstone, mostly silicious and abounding in organic relics. The next layer below it is light grey, and contains considerable carbonate of lime. The next is bluish and blue, and is chiefly carbonate of lime with some alumine and a little flint. The lowest layer is the *water limestone*. This last is the stone which hardens under water, after being burned, pulverized and made into a paste.* It consists of car-

* This remarkable property, hardening under water, was discovered by Canvass White, Esq. one of the Canal Engineers. He

bonate of lime, alumine and filex, with a little oxyd of iron. In the specimens which Mr. H. presented to the Troy Lyceum, grains of gypsum are disseminated.

Mr. McConihe examined a well twenty-five feet deep in this stratum, seventy miles west of Vincennes in Illinois, on a rising ground, which presented the following layers. The uppermost was rather coarse calcareous sandstone. The next seemed to be a talcose sandstone, of a flaty structure. The next calcareous sand, in a loose state. The lowest was almost wholly silicious sandstone.

From a comparison of specimens from the two localities, observed by Mr. Holley and Mr.

went to England to examine the canals of that country; and particularly to acquaint himself with the English method of constructing locks. On his return he brought home specimens of the rock, called *septarium*, which is used for locks on account of its hardening under water. He thought it resembled this variety of secondary sandstone; and on making trial, he found it to be equally well adapted to this use. The benefits resulting from this discovery in constructing locks and cisterns, is incalculable.

Mr. Hadley, Professor of Chemistry in the Fairfield Medical Academy, carefully analyzed it, and gave the proportions of all the constituents.

M^cConihe, it appears that the layers are in some measure analogous, but not similar. Is not this good evidence in proof of Bakewell's theory of local formations? It certainly accords with his inference, that "there might be great similitude in some situations, and much diversity in others."

IV. SUPERINCUMBENT CLASS.

STRATUM 15.

BASALT.

WHEREVER I have had access to the basis of a greenstone trap rock in place, I found it rested on a fine-grained variety, quite as fine as any specimens of European basalt. It is generally porous; being of that variety called amygdaloid, or toadstone. But specimens may be obtained several feet in extent, perfectly compact, without a pore.

This stratum is not only very different from the common greenstone trap in its texture; but its meeting with the greenstone is always

conspicuous. The two strata do not pass into each other by imperceptible gradations, nor alternate like some other strata. The west side of Mount Holyoke on Connecticut river, and the west side of Deerfield hill east of the academy, are good localities. Also most of the ridge of rocks which extends along the northwest side of Saltonstall's pond in East-Haven, four or five miles east from New-Haven.

In Deerfield there are basaltic columns of a polyhedral form ; in all respects resembling the joint of a basaltic column in Gibbs' cabinet from Giant's causeway, and of quite as compact a texture. These columns were first observed by Mr. Hitchcock. But were I to dispose of these rocks according to my own views of this subject, I would place these columns as well as those of Giant's causeway with the greenstone trap ; and make a distinct stratum consisting of the fine grained basalt, including the amygdaloid. For these two varieties often compose the same individual rock, and are much finer grained than the columns from Ireland. I have a specimen of basalt from Scotland, pre-

cisely resembling the fine basalt of Mount Holyoke, which underlays the greenstone columns.

The basalt of our district is remarkable for the numerous small minerals embraced in it. In Deerfield Mr. Hitchcock conducted me to a locality of this rock which contains prehnite, zeolite, chalcedony, agate, sardonyx, analcime, chabasie, stilbite, amethystine and lamellar quartz, and calcareous spar. Many of these minerals have been found at Mount Holyoke and Saltonstall's pond. Mr. Pierce found prehnite, zeolite and stilbite in this rock in New-Jersey.

I found specimens of this rock a little north of the greenstone columns in Mt. Holyoke, which resemble blacksmiths' cinders. The variety called amygdaloid is remarkably cellular; and the cells appear like those in light bakers' dough. Bakewell considers this peculiar structure as evidence of its having been fused and cooled under water, probably under the sea. "These beds of basalt," he says, "were formed under the sea by the ejection of lava, which flowing over the moist submarine ground, would confine a portion of water beneath the melted mass.

This water would be converted into elastic vapor, or steam, which would endeavor to expand. But where the superincumbent pressure prevented its escape, it would form cavities." He supposes the same eruption might form the cellular amygdaloid and compact basalt; as it would naturally be cellular below and compact above.*

* See Bakewell's Introduction to Geology, pages 141 and 142.

STRATUM 16.

GREENSTONE TRAP.

IN our district this rock appears as if piled upon other strata artificially. And Dr. J. W. Webster represents the greenstone about Edinburgh as presenting a similar appearance.* Travellers frequently compare them to the ruins of ancient castles.

There is a range of greenstone hills extending from New-Haven, Con. through the west parish of Hartford, through Northampton and Deerfield, to Greenfield; a distance of about one hundred miles. The three eminences arranged about New-Haven, denominated East Rock, Pine Rock and West Rock, belong to this range. The monument, or observatory,

* See his sketch in the *Am. Jour. of Sci.* p. 231.

west of Hartford is built upon a greenstone hill belonging to this range. Mount Holyoke and Mount Tom, near Northampton, are insulated fields of the same broken chain.

The range of this rock, which has excited the most attention, is that called the Palisadoes. It commences below the Highlands on the west shore of the river Hudson, and extends along, forming its western bank, with but one interruption, for thirty-eight miles. Opposite to the city of New-York it winds away westerly, across the state of New-Jersey to the distance of eighty miles.* The sublime emotions excited by the grandeur of these stupendous columns are familiar to the many thousands who have sailed up the Hudson.

In various parts of the greenstone trap of our district, we find very perfect polyhedral columns; and almost every where a polyhedral or rhomboidal tendency. The southwest side of Mount Holyoke presents a colonnade of the most perfect polyhedral pillars; imitating the nicest works of art. Joints of the columns are

* See Dr. Akerly's *Geology of Hudson river*, pages 27—32.

broken out in some places, so that the upper ones present their convex bases, resembling the bottoms of large potash kettles ; while the concave joints below will contain several gallons of water. The rock is remarkably fissile in every part of this mountain. When a joint of these columns falls, it is shivered into a thousand pieces.

The columns of West Rock, New-Haven, are not so regular in form ; but they are not so fissile. Besides, they break more readily into blocks suited for building-stone. Most of the walls in New-Haven are built of this rock.

The greenstone trap of our district generally rests upon red sandstone or red breccia. But there is a place at the southwest end of Mount Holyoke, where it seems to sink down into a rent or fissure in the red sandstone, passing under Connecticut river. There is a similar appearance at Deerfield river, just above its mouth, where it empties into the Connecticut.

A Scotch gentleman,* who has attended Jameson's lectures in Edinburgh, on examining

* Dr. McNaughton of Albany.

my specimens from Mount Holyoke, pronounce them the true *whinstone* of Scotland. This rock affords but few disseminated minerals. The fissures are sometimes faced with carbonate of lime, and rarely with zeolite. Mr. Silliman found considerable of the latter mineral in horizontal veins in Pine Rock. And I found considerable dark brown augite in the same locality. Mr. Silliman says, that most greenstone, if heated and pulverized, will form a water-proof mortar.*

Are basalt and greenstone trap of volcanic origin? This seems to be a subject of very general discussion among modern geologists. Bakewell says, "I am inclined to think that the part of Dr. Hutton's theory, which relates to the igneous origin of basaltic rocks, is as well established as the nature of the subject will admit of; other parts of the system are much less satisfactory.†

* See his note to the 142d page of Bruce's Journal.

† Page 135.

V. ALLUVIAL CLASS.

STRATUM 17.

GEEST.

THIS is the most universal of all strata. Every inch of dry land, which is neither naked rock nor covered with alluvion, is strewn over with geest. Its character is generally indicated by the rock upon which it lies, and by those which have recently disappeared.*

* Extract from an essay which I wrote for the Journal of the Board of Agriculture, published at Albany, page 58.

“The principal disintegrating agents are water and change of temperature. In all rocks we find natural cleavages. Rains and melting snows fill these cleavages with water; which, on freezing, extends its volume, and thereby subdivides the mass of rock into small portions. More surface being thereafter presented to the

That part of our section, which is included between the west boundary line of Massachusetts and the Atlantic, is principally covered with filicious geest, made up of fragments and

same action of the same agents, these small portions are still further subdivided, until a fine arable soil is formed.

“ There is a great difference in rocks in their adaptation to the action of these agents. A rock of granular quartz, for example, has but very imperfect natural cleavages. Consequently but little water can gain admittance. Besides, the hardness of the rock will long resist the expansive force of the freezing water. Whereas the common argillaceous slate contains an immense number of fissures or cleavages, and the texture is soft and yielding. Consequently soils are formed with great rapidity in slaty districts. As facts are preferable to any thing, however plausible, I will refer your readers to a few examples. Such examples must necessarily be local: your readers will therefore excuse me for referring them to a locality where I am perfectly familiar with the facts.

“ That part of the town of Chatham, in Columbia county, called the parish of New-Concord, has argillaceous slate for its basis rock. In this parish there are many fields traversed by ridges of slate rock, which were not covered with a sufficient coat of soil for cultivation a few years ago, but are now ploughed and cultivated like other parts of the fields. That those, who are curious to witness the most conclusive evidence of the rapid formation of soils from the disintegration of rocks, may not be subject to the labor of much enquiry or research, I will point them to a distinct locality. On the farm, now owned by Judge Patterson, and formerly by Capt. Abel Eaton, on the Union turnpike road, about fifteen miles from the city of Hudson, is the locality to which I allude. The highest ridge in a field on the

pulverized portions of primitive rocks. The narrow valley of Connecticut river is alluvion, and there are a few other very limited localities. Along the granular limestone valleys

east side of the road, being about one hundred and twenty rods northeasterly from the dwelling house, was one entire bare slate rock, about thirty years ago. This fact I well remember: but I will refer the reader to Mr. Hosea Birge, who still resides near the place for a confirmation of the fact. Now most of this same ridge is good arable land. That the present coat of soil could not have washed down from the hills above, is evident from the position of the ridge. For the ground between the ridge and the hill above is much the lowest. Consequently the earthy soil covering this ridge of rock must have been wholly formed by the disintegration of the rock within thirty years.

“ May we not safely infer that the earthy part of soils is perpetually undergoing changes in respect to quality and depth in some districts of country? For example, the rock overlaying the slate in the before mentioned parish, was graywacke. This is evident, not only from a consideration of the geological series of rocks, but from the fact, that some of the highest hills are still capped with graywacke. As graywacke is chiefly composed of grains of quartz, cemented together by a little alumine, soils formed of this rock must be too sandy and loose. May we not therefore presume, that many hundred years ago, the soil of that parish was more loose and sandy than at present, and consequently less productive? But since the graywacke rock has chiefly passed away, and perhaps mostly gone down the Hudson to form the Islands and shoals at its mouth: and since the slate rock has become exposed to the disintegrating agents, and commenced the operation of adding its substance to the graywacke soil, the earthy soil of this district is greatly improved.

through Pittsfield and Dalton, there is considerable calcareous and silicious geest and some alluvion.

Between the west bounds of Massachusetts and the river Hudson, the soil is chiefly argillaceous and silicious geest, composed of argillite and graywacke. Between the Hudson and Susquehanna rivers, along our section, it is more silicious, though a parallel section might be drawn about fifty miles north, which would pass through a country of alluvion alternating with calcareous and argillaceous geest. In our section, however, there are many patches of argillaceous geest, formed of the argillaceous layers of graywacke. There are also many patches of deep alluvion.

“ In the eastern parts of Columbia county the slate rock has passed away and left the granular limestone, which is the next stratum beneath it, bare. Near what is called Canaan Corner, is a manifest locality. Consequently, the disintegrating agents have commenced their attack upon it, and will greatly improve the neighbouring soil by the addition of carbonate of lime. In the western part of the same county, the upper, or secondary, stratum of limestone still remains above the graywacke. Consequently the soil is daily improved in that district by the mouldering down of that rock.”

On a general view of our district, we may consider the New-England states and the north, east, and southeast, part of the state of New-York, as the proper territory of geest. This portion of our district, however, embraces several hundred square miles of alluvion. Particularly along the banks of the great rivers, near the shores of the sea and on the islands.

Though this stratum is generally made up of the disintegrated fragments of the nearest rocks, some of its constituents appear, in many localities, to have been transported from a considerable distance. More especially where it is situated near the base of a high mountain. There may also have been considerable commixture between the geest of different parts of level tracts, before the subsidence of the oceanic waters left it bare. But it generally appears to be very nearly related to the existing basis rock.

STRATUM 18.

ALLUVION.

HITHERTO there has been no subdivision of this stratum, founded upon the relative ages of different layers. Gravel, sand, clay and loam are said to compose this stratum ; either, or all, of which may be in any place or of any age. After I had collected my materials for this stratum and arranged them in the usual way, I received a letter from Mr. Henry R. Schoolcraft which set me upon a new course of enquiry. He proposes to subdivide this stratum according to the relative ages of the different kinds, and assigns distinctive characteristics for each kind. It would be very gratifying to me to publish his letter ; but it was written in haste at the last moment of his departure on the Northwestern

expedition with Gov. Cals, and in a familiar style which evinces that he did not expect me to take that liberty.

After applying his suggestions to all the facts within my knowledge, I am inclined to consider the three-fold division, which he proposes as hardly tenable. I shall attempt a two-fold division, upon this plan, leaving all further improvement to be made by Mr. S. after his return, when his stock of materials will be fully adequate to the object.

Primary Alluvion.

This is that kind of alluvion, which appears to have been formed when the earth, or at least that portion of it in the vicinity of such alluvion, was destitute of vegetables. Consequently there are no trunks of trees, nor other vegetable remains, embraced in it nor under it. The alluvion embracing the iron ore beds of Salisbury, Con. is a very perfect example. The banks of alluvion along the east side of this city (Troy) are also primary. Mr. Schoolcraft considers the alluvion embracing the lead ore

of Missouri as truly primitive. I have seen ochre in Williamstown, Mass. and in Blenheim, N. Y. in this kind of alluvion ; also bog ore in the latter place, and in the Highlands.

Having examined but few localities since this very interesting suggestion reached me, I dare not venture to name even those localities, with which I am very familiar. These remarks will be sufficient to induce the reader to make those enquiries, which will materially aid this department of the science.

Secondary Alluvion.

This kind always embraces or covers trunks of trees, vegetable mould, or some other remains, which proves its formation to have taken place since the earth's surface has been adorned with "an abundant vegetation." Such is the bed of alluvion on which this city, (Troy) is built. It appears by digging the wells in this city, that after descending from fifteen to twenty feet through the coarse gravel, there are two or three layers of tough clay. Among this clay are found great quantities of leaves, trunks and limbs of trees, &c. There is now in th^e

Troy Lyceum a fragment of the *pinus canadensis* (hemlock tree) which was interposed between two layers of this clay twenty-five feet below the surface.

Most of Long-Island and other alluvial localities in the vicinity of New-York are secondary alluvion. It appears also, that the alluvion forming all the eastern portion of the Southern states, is of this kind.

A few miles south of Lake Ontario there is a large tract of secondary alluvion, containing argillaceous oxyd of iron of the lenticular variety. The alluvion is reddish and seems to be underlaid with red sandstone. The ore frequently contains very perfect, though extremely minute, *volutites*. They are perfect petrifications, being wholly composed of the argillaceous oxyd of iron, though they are of the same species as those minute *voluta* now common in the living state. Excellent iron is manufactured from this ore; and the Legislature of this state have granted a loan to Gen. M'Clure and A. Cole, Esq. to enable them to carry on the manufacture of it to advantage. These gentlemen, from whom I received this description of the al-

luvion, presented to the Troy Lyceum specimens of the ore with a bar of the wrought iron. On an analysis we find that it yields a little over thirty per cent of pure iron. The Rev. R. Searle found a similar locality of small extent twenty-five miles south of lake Erie.*

The bones of large animals are frequently found in the secondary alluvion; also vast quantities of shells in a perfect state of preservation. Though large bones have been found near Newburg on Hudson river, &c. yet they are more frequent in the alluvion of the Western States.

It is worthy of notice, that trunks of trees, which have lain for centuries in deep alluvion in a sound state, will decay in a very few months when dug up and exposed. I have seen a sound log, one foot in diameter, totally rotted into a powder in one year, which had been thrown up from a considerable depth by the roots of a falling buttonwood (*platanus occidentalis*) of an enormous size, probably one hundred years old. Similar observations are frequently made by well-diggers in alluvial districts.

* See American Jour. Science, page 239.

The peat beds of New-Haven, of Dutchess county,* &c. belong to this kind of alluvion ; also many anomalous rocks of recent local formation. Those petrifications which are formed of calcareous tufa, as the enormous lignite discovered by Mr. J. C. Heartt in Madison county, are proper subjects of this formation. There is in the Troy Lyceum a very extraordinary specimen of *holzstein* (femi-agatized wood) which was taken from secondary alluvion near Mobile. It is the trunk of a tree fifteen inches long and six inches in diameter. Forms of knots upon it are very perfect, and the grains of the wood distinctly imitated. Its most remarkable peculiarity is, that several petrified specimens of *Xylostroma gigantea* are contained in cleavages of it, which still retain the natural colour of that fungus.

To enumerate the many substances contained in secondary alluvion would exceed the plan of this Index. Indurated marl is found in it near Albany, Troy, Catskill, and in numerous other localities in the state of New-York. In New-England marl is extremely rare. Dr. Wm.

* Rev. F. C. Schaeffer.

Bridgman found it however, in Wilbraham, Mass. of a reddish hue, and I found a grey variety at Northampton in small quantities. Petroleum (liquid bitumen) often issues from this kind of alluvion and forms an iridescent pelticle upon standing waters. Vast quantities of it are found at Seneca Lake, where it is called mineral oil. Dr. Mitchill found native sulphur in it at Clifton Springs near Geneva. Mr. C. I. Wistar found amber in it with coal near Trenton, N. J. and Mr. Godon found at Allentown an excellent pigment of blue earth containing phosphate of iron.*

Most waters, which pass through clay alluvion, contain muriatic acid, (spirit of salt) generally combined with lime. A solution of muriate of soda is often found in other varieties of alluvion; but it seems to pass through them with rapidity, and on its passage to be decomposed by carbonate of lime and to be detained only in the adhesive and compact layers of

* Mr. Schoolcraft observed pebbles of granite, gneiss and hornblende rock, intermixed with the sandy and calcareous alluvion, in the vicinity of the Vienna gypsum, Ontario county: which is very far from any locality of these rocks, being in the midst of a secondary country.

clay. I cannot give my views of this subject better, than to transcribe a short paper which I read before the 'Troy Lyceum.

“ From the experiments and observations of Dr. J. B. Beck,* Dr. John Torrey,† Dr. S. Akerly and others, it appears that some storms bring with them large quantities of muriate of soda (common salt) to a little distance from the sea. Are there not sufficient reasons for believing that many storms bring with them muriate of soda far into the interior, or even across the continent? I do not intend to detain the members of the Lyceum with a long dissertation upon this question. But I will relate a few facts which have come to my knowledge, with a view to induce further enquiry.

“ I have analyzed what is called the hard water of wells in Waterford, Lansingburgh, Troy, Albany, Hudson, Athens, Catskill, Cairo, Durham and Blenheim, in the state of N. York, and I find, they all contain muriate of lime. There is no difficulty in accounting for the presence of the lime; but whence comes

* Am. Jour. Science, p. 383.

† Note to page 390.

such an immense and continued supply of muriatic acid? For there is no evidence of the existence of any salt mines in or near these localities. But since they are all embraced in a transition country, we are authorised to presume there are none.

“ May it not be supplied by storms, bringing with them muriate of soda into the *interior* of our continent, as well as near the sea-board, differing only in quantity? Troy is about one hundred miles from New-Haven, which is the shortest distance to the sea, and Albany is but six miles from Troy. Now I have tested water, falling in sudden showers and long rain-storms, repeatedly, at both these cities with the best prepared nitrate of silver, and generally found that it contained muriatic acid. I have not always found it in snow water, but I did at one fair trial in Albany.

“ To avoid the possibility of error, I always collected it in a glass vessel placed in an open yard at a distance from any building or tree. And in order to be sure that no muriatic acid could by any possible means adhere to the vessel, I always filled it with pure water, tested by ni-

trate of silver, the last moment before I began to collect the water.

“ Is not one of the provisions of nature for fertilizing soils and correcting impurities, that of transporting sea-salt to every part of all islands and continents, in combination with aqueous vapor? Are not all other methods of accounting for the almost universal presence of muriatic acid in soils at variance with known phenomena ?”

The rapidity with which alluvion is formed is incalculable. The following observations upon the quantity which passed by Albany, during three days of the freshet of April 1819, may be somewhat interesting. That part of the river, which included the strength of the current during the freshet, was 1320 feet wide and fifteen feet deep on an average; giving the area of a transverse sheet of 9800 square feet, opposite to the Steam-boat dock. By measuring the distance from this dock to the ferry stairs, and repeatedly marking the time required for logs, brush, roots, &c. to pass this distance, I ascertained that the average velocity of the wa-

ter for three days in succession was four miles per hour. Consequently 12,544,000 cubic feet of water passed every hour. During the three days, I collected water from time to time, which I set into a close closet for six days to settle. And I found the earthy sediment averaged almost precisely one grain to a quart of water. Consequently, leaving out all fractions, about twelve hundred tons passed Albany in three days; or a four hundred ton ship-load each day.

Though this alluvial earth was not formed during the freshet, it was at some time or other produced by the disintegration of rocks. And since similar freshets are frequent, rocks must dissolve with great rapidity to furnish all our great rivers with the vast quantities of alluvial earth, which they transport annually to their mouths, and with which they form islands, peninsulas, &c.

REFLECTIONS

ON THE HISTORY AND STRUCTURE

OF THE

EARTH.

KIRWAN, De Luc, and several other geologists have adduced many geological facts as collateral evidence in support of the authenticity of Divine Revelation. And though Kirwan has compared the order of creation, as related by Moses, with his theory of the earth, I do not know that any one has noticed the following coincidence of a few well authenticated facts.

1. It appears by the history of creation given in the scriptures, that the materials constituting the earth were created and its solid basis finished, before animals or vegetables were form-

ed. In accordance with this fact, we now perceive that there are no petrifications, or organized remains of animals or vegetables in the earth, excepting those which are intermixed with the outer and more recent strata, evidently derived from the earth's surface.

2. Aquatic animals were formed first according to Moses. This is confirmed by the established fact, that no other relics, but those of the aquatic kind, are contained in transition rocks, which are the oldest containing any relics.

3. Dry land animals and plants were formed subsequent to the creation of aquatics according to Moses, and before the creation of man. Now we find the remains of dry land animals and plants in the newer, or secondary, rocks ; but not the fragment of a bone or any other part of man has ever been found in either transition or secondary rocks.

4. Man was created last, after the earth was completed and parts of it covered with herbage ; of course after the process of disintegration had commenced and soils were formed. In con-

firmation of this fact, we find the remains of man no where but in the alluvion, out of which he was formed. A specimen has been found in Guadaloupe consisting of part of a human skeleton, embraced in an aggregate of calcareous sand, considerably indurated; but not in a secondary rock stratum.

5. Moses says, the Lord made “every herb of the field before it grew”—“whose seed is in itself,” &c. This accords with the well known fact, that new plants are still springing up from seeds, probably planted at the creation, wherever forests are cut away and other steps taken to prepare particular patches of earth for giving growth to such particular plants. It is even said, that pulverized rocks have been known to afford seeds and to give growth to new plants. Perhaps this latter fact is not well authenticated.

It is true that six days is but a short space of time for the deposition of strata and for those other events to have transpired in succession. But we know that all operations were hastened in effecting so much in so short a time; and we are only to believe, what is certainly most rational, that though these operations were hasten-

ed, the Almighty established laws for governing his works at the very first, and endowed the first created atom with its present properties.*

I do not pretend that this coincidence of scripture history and geological discoveries is alone sufficient, or at all necessary, to support the authenticity of Divine Revelation. But it is not unworthy the attention of the geologist. Suppose this order of things were reversed. Suppose the remains of man alone were found in primitive rocks, dry land animals and plants alone in transition, and aquatics alone in the most recent secondary rocks, would not every Deist declare this to be conclusive proof, that scripture history could not have been given by inspiration?

From these few remarks it appears that, by attentively studying the present structure of the earth, and by duly considering the millions of organized beings whose remains are almost every where in the more recent strata, we may arrive at some correct views of the history of our

* Some learned Divines suppose each day to have been a thousand years, since with the Almighty "a thousand years are as one day, and one day as a thousand years."

planet. Cuvier says, “ would it not be glorious for man to burst the limits of time, and, by a few observations, to ascertain the history of this world, and the series of events which preceded the birth of the human race?”

Many of the great revolutions which our earth has undergone can be traced by existing monuments within our reach. “ When the traveller,” says the illustrious Cuvier,* “ passes through those fertile plains where gently-flowing streams nourish an abundant vegetation, and where the soil, inhabited by a numerous population, adorned with flourishing villages, opulent cities and superb monuments, is never disturbed except by the ravages of war and the oppression of tyrants, he is not led to suspect that *Nature* also has her intestine wars, and that the surface of the globe has been much convulsed by successive revolutions and various catastrophes. But his ideas change as soon as he digs into that soil which presented such a peaceful aspect, or ascends the hills which border the plain.”

* See Cuvier's Theory of the Earth, New-York Ed. p. 29.

Shells and other marine productions “ are
“ found in elevations far above the level of ev-
“ ery part of the ocean, and in places to which
“ the sea could not be conveyed by any existing
“ cause. Still we are forcibly led to believe,
“ not only that the sea has at one period or
“ another covered all our plains, but that it
“ must have” overtopped the hills and “ re-
“ mained there for a long time in a state of
“ tranquillity.”——“ The breaking to pieces
“ and overturnings of strata show plainly that
“ those catastrophes were sudden and violent.
“ Life, therefore, has been often disturbed on
“ this earth by terrible events.”

I will not detain the reader with any further *general* reflections upon the history or present structure of the earth. The works of Cuvier, Bakewell and De Luc contain every thing to gratify the most brilliant fancy, or the most rational curiosity. But with respect to our own country I will suggest, that if we suppose most of the primitive rocks to extend throughout North-America, sometimes supporting other strata and sometimes exposed to our view from the disruption or disintegration of the higher

strata, almost every geological phenomenon may be explained. We should then say, that in New-England the granite does not lie very low any where; and that in certain places it is laid bare. That in the western states it generally lies very low, and is entirely concealed by transition and secondary rocks. And that beyond the Mississippi it is considerably elevated, so that it becomes visible in Arkansas. Also that it comes so near the surface for seven hundred miles along the west side of the Mississippi, as to raise up its associates, granular quartz and primitive limestone, to view.*

* See Schoolcraft's observations in a note to this Index, p. 226

CORRECTION.

At the 124th page it is said that the mountain range of gneiss, mica-slate and talcose rock including Saddle Mountain, is insulated or peninsular, on account of the meeting of the two ranges of granular limestone. Since that part of the Index was struck off, the 2d Vice President of the Lyceum, David Bucl, Jun. Esq. has attentively traced the western range of lime rock, and finds it interrupted for a narrow space by a branch of the talco-micaeous rock, which crosses the valley near the southeast corner of West-Stockbridge. This branch directs its course towards the Tagheon-nuc mountain, and may be the connecting link between the Highland and Hinsdale primitive ranges.

Explanation of the Plates.

IN addition to explanations of PLATE I. in the fore-part of the book, it should be observed that Fig. 3, is to represent a secondary country, where both transition and secondary rocks appear. By attending to the numbers of the interrupted fields and patches of different strata, a pretty correct view of the secondary country to the west may be formed. The figures represent the strata as follows : 1. Granite, 2. Gneiss, 3. Hornblende rock, 4. Mica-slate, 5. Talcose rock, 6. Granular limestone, 7. Argillite, 8. Metalliferous limestone, 9. Graywacke, 10. Red sandstone, 11. Breccia, 12. Compact limestone, 13. Gypsum, 14. Secondary sandstone, 15. Basalt, 16. Greenstone trap.

PLATE II. is intended to represent the probable appearance of the rocks between Susquehanna river near Jericho in the state of New-York, and the Atlantic ocean at Boston in Massachusetts. The rocks on the surface are laid down from actual observation; and, from an attentive consideration of the facts recorded in this Index, it is inferred, that should these rocks be cut across several miles in depth, they might present appearances in some measure resembling these drawings. The height of the mountains, &c. is greatly disproportioned to the real extent of the section. In such a section the deformities of the country must be highly caricatured, in order to represent them to advantage on a plate.

The lower section on the plate is but a continuation of the upper one. The figures represent similar strata with those set down for Fig. 3, Plate I.



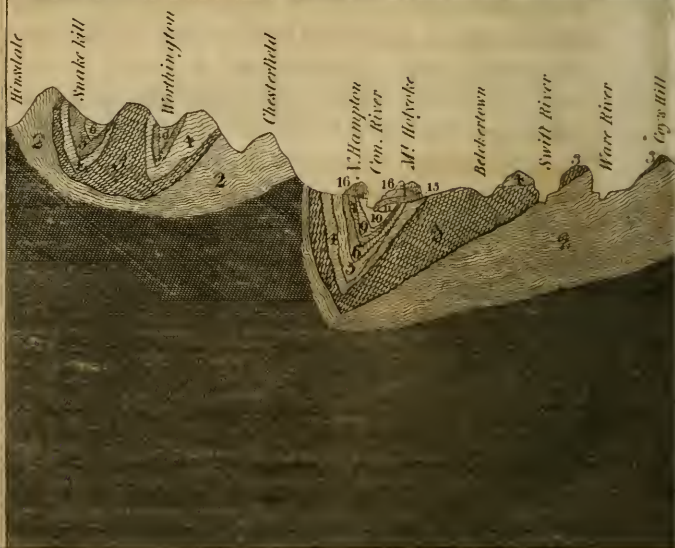
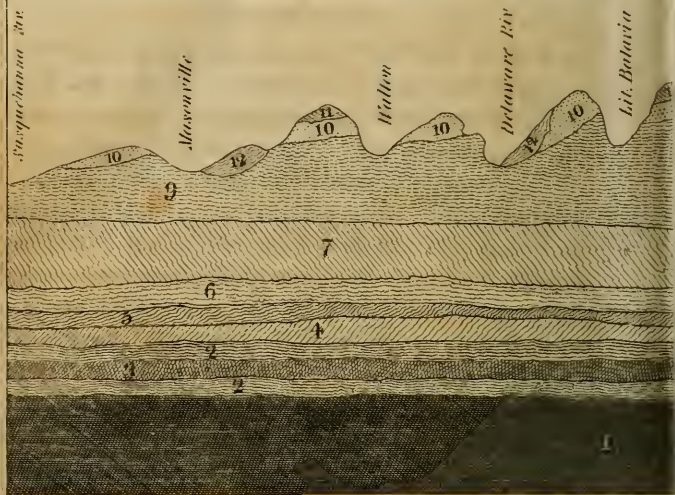
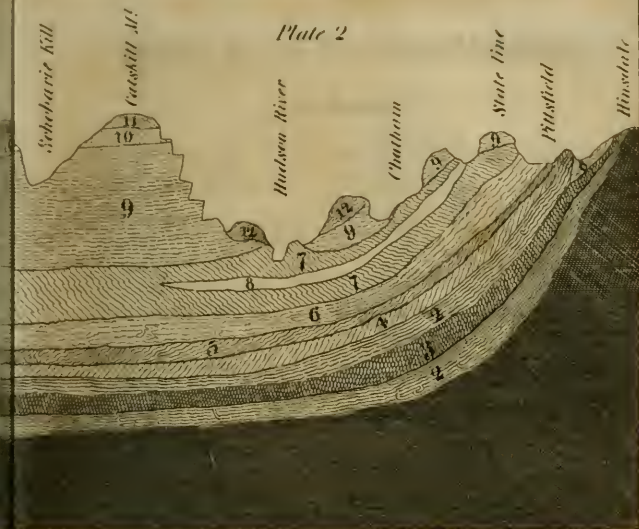


Plate 2





INDEX AND VOCABULARY.

A		Basalt	46, 134, 249
ACTYNOLITE	138	Basanite	177
Adularia	94	Bed, an extensive	
Aggregated, united by		mass interposed be-	
adhesion.		tweenstrata or layers	165
Agate	251	Beryl	93, 104, 118, 121
Agate breccia	221	Bismuth	104, 105
Agriculture	58	Bitumen, a mineral	
Alluvial class	28, 48, 257	substance in appear-	
Alluvion	49, 262	ance resembling	
Alphabet	19	pitch. It gives the	
Alum-slate	175	peculiar odour to	
Amethystine quartz,		burning pit coal.	
it is violet blue	251	Bituminous shale	234
Amphibiolite	70	Blende	111
Amygdaloid	46, 134, 249	Blocks, fragments of	
Amorphous, without		rocks, in size between	
any regular shape,		pebbles and boulders,	
uncrystallized.		perhaps between six,	
Analcime	251	and twenty-four, inch-	
Analysis of soils	60	es in diameter.	
Anhydrous, not con-		Bones	218, 219, 266
taining any water.		Boulders, large frag-	
Anomalous	166, 179	ments of rocks ; larg-	
Anthracite, hard shin-		er than blocks.	
ing coal which burns		Breccia	42, 194, 217
without smoke	163	Breccioids, resembling	
Antimony	212	breccia in appear-	
Argillaceous, clayey.		ance but not in geo-	
Argillite	21, 36, 163	logical relations	221
Arsenic	118, 138	Brittle slate	191, 209
Asbestos	161	Buel's observations	126
Augite	105, 161	C	
B		Calcareous sandstone	35
Barytes	101, 111, 131, 165.	Calcareous spar, crys-	
	[202]	tallized, or semi-crys-	

- | | | | |
|--|---------------|---|---------------|
| tallized carbonate of lime | 251 | the coats of an onion, all having a common centre. | |
| Capillary, shaped like a hair. | | Concholite | 75 |
| Carbon, the basis of charcoal. | | Concreted limestone | 233 |
| Carbonate, any compound consisting of a base chemically combined with carbonic acid. | | Conservatives | 67 |
| Carbonate of iron | 104 | Copper | 101, 185, 212 |
| Carbonic acid, the basis of charcoal chemically combined with oxygen. | | Copperas water | 117, 131 |
| Carburet of iron | 173, 202 | Corallinite | 199 |
| Catskill Mt. | 193 | Corals | 85 |
| Caverns | 230, 232, 239 | Creation, history of | 273 |
| Chabasie | 251 | Crystalline limestone | 154 |
| Chalcedony | 104, 239, 251 | D | |
| Chalk | 233 | Dalaby's observations | 126 |
| Chalybeate springs | 117, 204 | Decomposition, the separation of the constituents of bodies by chemical means. | |
| Chlorite | 22, 173 | Deliquesce, to dissolve by the moisture of the atmosphere. | |
| Chlorite slate | 173 | Dendritic, tree-shaped. | |
| Chrysoberyl | 93 | Diamond rock | 177 |
| Classes | 25 | Disintegrating agents | 257 |
| Cleavage, a natural fissure or place of separation in a mineral. | | Disintegration, the crumbling down of rocks into alluvial soil. | |
| Clinton's discourse | 127 | Disseminated, when small minerals are scattered or interspersed in the substance of larger ones, or in rocks. | |
| Coal | 210, 239 | Dolomite | 35, 161 |
| Cobalt | 118, 138 | Drawing-slate | 174 |
| Coccolite | 105 | E | |
| Columns | 250 | Efflorescence, the powder on some saline or alkaline substances by | |
| Combustibles | 53 | | |
| Compact limestone | 43, 222 | | |
| Concentric, when spherical layers lie over each other like | | | |

exposure to the atmosphere.		theory of the formations.	
Elastic marble	161	Giant's causeway	250
Entomolite	71	Gibraltar	215
Epidote	138	Glance, a German word for shining.	
Erismatolite	85	Glass sand	146
F		Glossed argillite	173
Fascicular, composed of several needle-form diverging crystals.		Gneiss	32, 112
Felspar	20, 93, 103	Granite	31, 91, 111, 228
Fish, impressions of	163, 215	Granular limestone	35, 123, [124, 154]
Fibrous quartz	174	Granular quartz,	35, 123, [177, 228]
Filiform, in the form of threads.		Graphic slate	174
Fissile, easily split into parts.		Graywacke	38, 187
Flint	229	Greenstone porphyry	133
Flinty slate	209	Greenstone trap	47, 134, [137, 253]
Floetz, a German word used to denote flat or nearly horizontal strata.		Grindstone	195
Floetz limestone	43	Gritstone	39
Fluor spar, fluoric acid combined with lime,	101, [111]	Gypsum	22, 44, 227, 237
Freestone	209	H	
G		Hard water	269
Garnets	144, 145	Helmintholite	71
Geest [pronounced jé-est, derived from <i>ge</i> , land, and <i>esti</i> , is]	48, [257]	Hematitic ore	150
Geognosy, nearly the same as geology. Though some geologists apply it more particularly to the		Hepatic water	175, 204
		Holzstein	267
		Hornblende	21, 118, 140
		Hornblende rock	32, 133
		Hornstone	229
		Hydrogen gas, inflammable air, the basis of water.	
		I	
		Ichthyolite	71
		Indicolite	121
		Iridescent, coloured like the rainbow.	
		Iron	104, 113, 132, 145, [149, 161, 265]

J		Melanite	132, 145
Jasper	174, 234, 239	Metalliferous, contain- ing ores or metals	
K		Metalliferous	lune-
Kalmia	211	stone	37, 164, 181
L		Metals	55, 210
Lamellar, consisting of plates.		Mica	20, 93, 121
Lamellar quartz	251	Micaceous iron	149
Laminae, thin plates or leaves.		Mica-slate	34, 142
Lava	28	Milford marble	160
Lead	100, 101, 111, 185, [202, 228]	Milky quartz	173, 179, 217
Lenticular, shaped like a double convex lens, or a spectacle glass. When the resem- blance is but very distant, it is still call- ed lenticular.		Molybdena	93, 94, 109
Lenticular iron ore	265	Money-diggers	109
Lias stratum	222	Muriatic acid	268
Limestone	22, 35, 43, 228	N	
Lithographic stone	232, [239]	Nagelfluh	220
Lydian stone	177	Niagara	214
M		Nodule, protuberance or knob.	
Magnesia	152, 161	Nova-Scotia	217
Magnetic, attracted by iron.		Nutriment	62
Mammodolite	70	O	
Manganese	124, 203	Obsidian	28
Marble	162, 226	Oceanic	230
Marl, a compact mass of carbonate of lime, clay and sand,	62, 367	Ochre, alluvial earth of various kinds com- bined with oxyd or carbonate of iron.	
Mechanical deposits, beds or layers which were deposited from a state of suspension in water.		Opal	239
		Organic relics	66
		Oxygen, pure respira- ble air. When com- bined with a metal, it forms a rust or oxyd of it.	
		P	
		Palisadoes	254
		Peat	267
		Pebbles	50
		Petrifactions	67
		Petroleum	268

Petro-silex	104	Quartzose, chiefly	
Phosphate of lime*	110,	made up of quartz.	
	[132	R	
Phytolite	90	Rain	270
Pinite	144	Red sandstone	40, 206
Plumbago, or black		Reflections on the	
lead, consists of car-		Earth, &c.	273
bon with a little iron	94,	Relics	66
[105, 109, 113, 118, 124		Rock-salt	44, 241
Porphyritic gneiss	115, 116	Rocky Mt.	106, 228
Porphyry	33, 134	Rubblestone	33, 183, 190
Potstone, a fine close-		S	
grained variety of tal-		Salisbury mine	150
cose rock	147	Salt	44
Precious stones	53	Sandstone	40, 44, 227
Prehnite	133, 251	Sappare	145
Primary alluvion	263	Sapphire	203
Primitive class	25, 31, 91	Sardonyx	251
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		Specular, having pol-	
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* Since this work went to press. Dr John Torrey has informed me, that he and Mr. Pierce have discovered crystals of phosphate of lime in mica-slate near N. York, one inch in diameter.

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